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The SCIENCE COUNSELOR

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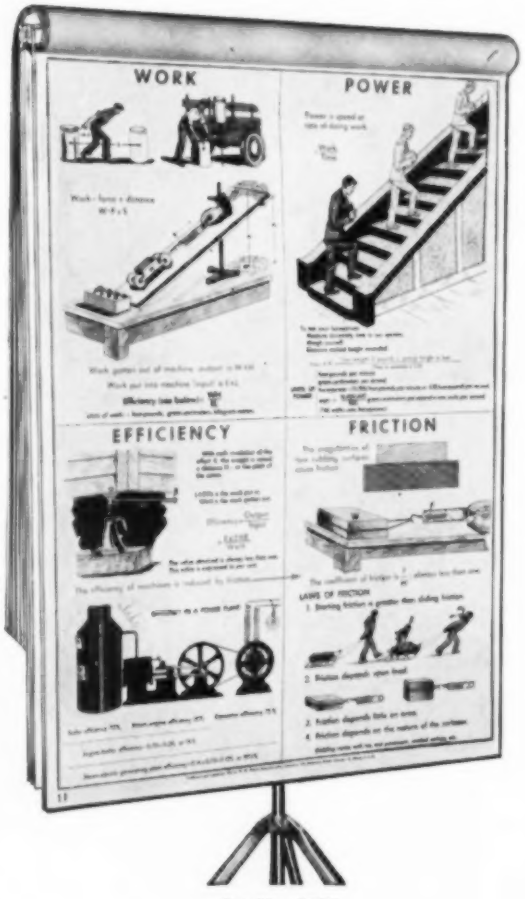

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Volume XVII December, 1954 No. 4

CONTENTS

IN FUTURE NUMBERS 117
THE SIGHT OF SOUND 118
CHANGING EMPHASIS IN INSTRUCTION ABOUT ALCOHOL 121
Raymond G. McCarthy
THE CATHERWOOD DIATOMETER 123
Matthew H. Hohn
THE IMPORTANCE OF MAGNESIUM IN HUMAN NUTRITION 125
S. Marcovitch
NOT CHALK AND TALK 127
Lydia Bourne Walsh
LAUNDEROMETRIC EVALUATION OF SOME CELLULOSE DERIVATIVES 129
J. V. Karabinos
ULTRASONICS — A PHYSICAL TOOL FOR BIOLOGICAL RESEARCH 130
Nelson H. Newton
MODERN TRENDS IN HIGH SCHOOL CHEMISTRY 133
Sister M. Lawrence
SLANTS ON CONSERVATION EDUCATION 136
N. R. Casillo
THE STORY OF HYPODERMIC SYRINGES 138
CURRENT SCIENTIFIC WRITING 139
Lois Kennedy
NEW BOOKS 141

In Future Numbers . . .

Among the articles planned for publication in the near future are:

Science Careers for Women
By Howard A. Meyerhoff, Executive Director, Scientific Manpower Division, Washington, D. C.

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THE SIGHT OF SOUND

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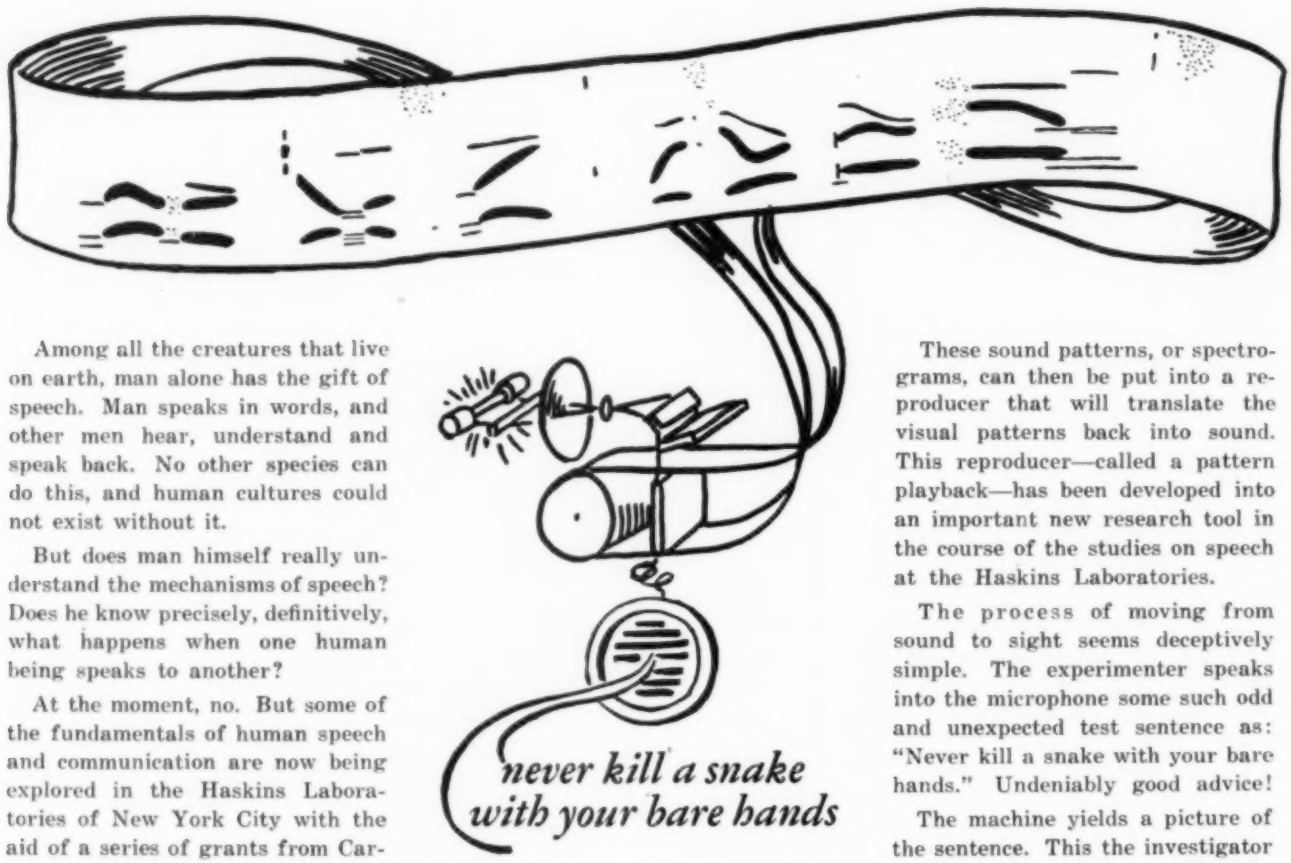


Among all the creatures that live on earth, man alone has the gift of speech. Man speaks in words, and other men hear, understand and speak back. No other species can do this, and human cultures could not exist without it.

But does man himself really understand the mechanisms of speech? Does he know precisely, definitively, what happens when one human being speaks to another?

At the moment, no. But some of the fundamentals of human speech and communication are now being explored in the Haskins Laboratories of New York City with the aid of a series of grants from Carnegie Corporation and other sources, and the answers are beginning to come.

Speech, of course, conveys a good deal more than just the meaning of words. The identity and personality of the speaker, the quality of his voice, the fear, the joy or other emotional coloring he gives his words, where he puts stress and emphasis—all these things and many more go to make up the living stream of verbal communication. Eventually they must be studied if complete understanding of human speech is to be achieved.

But the scientists have sought to begin at the beginning. They want to know what brings about the very first step—recognition of words. How does a person hearing the word "bat," for example, recognize it as "bat," and not "pat" or "mat"?

To get at this problem they use pictures of sound. They get the pictures from the spectrograph, an instrument originally developed in the Bell Telephone Laboratories and specially modified for the purposes of this research. When words are spoken into the microphone of the spectrograph, this machine puts on film a visual record of the sound patterns involved. This is, in a very literal sense, visible speech.

These sound patterns, or spectrograms, can then be put into a reproducer that will translate the visual patterns back into sound. This reproducer—called a pattern playback—has been developed into an important new research tool in the course of the studies on speech at the Haskins Laboratories.

The process of moving from sound to sight seems deceptively simple. The experimenter speaks into the microphone some such odd and unexpected test sentence as: "Never kill a snake with your bare hands." Undeniably good advice!

The machine yields a picture of the sentence. This the investigator may study, revise or turn back into sound by putting it on the playback.

What do these pictures of speech look like? The spectrogram shows an intricate layering of heavy strokes and fine lines, corresponding to the web of tones and overtones that is the complexity of human speech.

Another speaker tries the same sentence. This time the spectrogram is different. There is a different voice, different timing, different tones, different stress. All these differences are registered in subtle variations of line and shading in the spectrogram. In a sense, each spectrogram is as individual as a thumb print.

But the speakers are saying the same words. Many speakers try the same sentence. The spectrograms are compared. Upon analysis, certain features common to all of them become apparent.

These are the least common denominators. They show which portions of the total pattern are absolutely essential to recognition of syllable, word or phrase. These are the fundamentals. Is it possible to disregard some of the feathery surrounding lines that identify the indi-

vidual speakers and their manner of speaking and still hear intelligible speech?

The scientists try just that. With white paint they make tracings of the spectrogram on transparent tape, ignoring the fine detail and tracing in only the broad outlines. The painted pattern that emerges is far simpler than the original, a pattern now of only a few dots and strokes—a kind of cartoon of the speech picture.

This is fed into the playback. Gone is the human warmth and color—the New England twang of this speaker, the bubbling sense of fun of that one. Out of the machine comes a flat, colorless monotone—but the words are clearly recognizable. What began as a *spoken* sentence is now *simplified* speech, and from the parts left out of the painted pattern one can find which parts of the spoken word can be discarded and which must be retained if speech is to be understood.

The investigators have here a reliable tool. Systematically they can explore the forty or so basic sounds, or phonemes, of our English language. Sound by sound, syllable by syllable, they can find out just what it takes to make human speech recognizable.

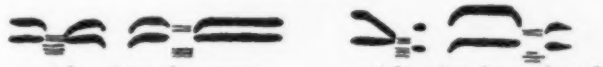
But what if the investigators didn't have actual recordings from which to trace their patterns? Are the lines and curves that they have been using sufficiently regular to stand alone, free of the original? Can the scientists use "standardized" patterns painted freehand, and can such contrived patterns also convey intelligible speech?

They can. The freehand patterns can be made to speak as clearly as those that have been traced from a spectrogram. This is *synthetic* speech in its truest sense.

When the scientists try one of these freehand patterns on the playback, the result is eerie. That flat monotone—the very voice of a machine. Another of those maddening, semi-nonsense test sentences: "A big, bad man demanding money can kill you. Bang! Bang!" The hearer can recognize every word, every syllable. This is speech. Yet no human ever spoke it. No sound, no breath, no vocal cord brought this into being. A pattern of paint on film—and you have speech.

The scientists can go much further. By altering the pattern in slight and subtle ways, quality and accent can be changed in predictable fashion. Thus, the word "Alabama" can be given the characteristic drawl of a Southerner, or the accent of a Frenchman. It is possible to work with any language, analyzing its characteristic modes of pronunciation and its dialects, and to compare with a new order of precision the various languages of the world.

"ALABAMA"



. . . with a French accent *. . . with a Southern drawl*

These findings open large and fascinating vistas. If sounds as complex as those of human speech can be reproduced with a paint brush, can other sounds also be captured in visual patterns? Can music, for instance, be painted directly on a film? This too has been tried—amusingly and with some success.

Again, there is the matter of shape. Can one recognize a triangle, for example, by its sound? In a measure, this seems to be possible. When various triangles are put through the playback, they produce roughly comparable sounds. Similarly, circles painted on the films sound rather like other circles and ellipses. There is, it seems, a sight-sound transform—a relationship between our perceptions of "pattern," whether experienced through the eyes or through the ears. The theoretical interest of such phenomena to the psychologist is considerable. There is a practical relevance also to the problems of helping the blind to "see" with their ears, and the deaf to "listen" with their eyes.

The principal investigators in these studies are Franklin S. Cooper, associate director of the Haskins

Laboratories, Pierre Delattre, professor of Romance languages at the University of Colorado, and Alvin M. Liberman, associate professor of psychology at the University of Connecticut. Many other scholars from many lands have helped in the work.

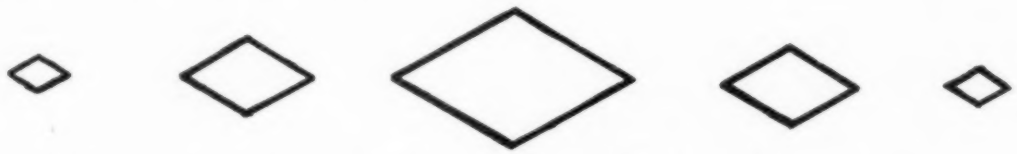
The Haskins Laboratories were established in 1935. They are incorporated in New York State as a non-profit educational institution for basic research and research training. The staff numbers approximately forty. The organization is devoted to the role of "uncommitted investigator," prepared to explore scientific frontiers and the borderlines between established fields in the hope that the findings so achieved may become growing points of fresh knowledge. The work of the laboratories has been supported by various agencies including the Rockefeller Foundation, the American Philosophical Society and the National Academy of Sciences, and to some extent by funds contributed privately and by certain business organizations. Work is done also under government contract. The Carnegie Corporation has helped to support the program in speech perception since 1947 with grants totaling $200,000. Caryl P. Haskins, founder of the laboratories and director of research, also serves as a consultant to Carnegie Corporation.

Cooper and his associates estimate that they are perhaps halfway through their avowed task of exploring the basic sounds of English speech. They have gained new insights, and they see important new areas yet to be explored.

This is basic research, research into the central processes of perception and recognition that underlie the understanding—and the more effective use—of the spoken word. Its ultimate applications are as broad as human society itself, for if men are to cooperate they must first communicate. ●

Triangles produce roughly comparable sounds . . .

so do circles and ellipses.



Can you translate sight into sound and sound into sight? All this is for the future.

Changing Emphasis in Instruction About Alcohol

• By Raymond G. McCarthy
ASSOCIATE PROFESSOR, HEALTH EDUCATION, YALE UNIVERSITY, NEW HAVEN, CONNECTICUT

Certain popular high school textbooks contain statements about alcohol and its effect on human subjects that should be questioned.

Some texts bracket alcohol with the opiate drugs. Teachers and textbook writers may learn here why such a practice is indefensible.

Textbook emphasis has always been on the supposed pharmacological effects of alcohol, but informed persons know that the pharmacological action of alcohol is not the primary cause of alcoholism. The problems associated with excessive and uncontrolled drinking are not solely physiological and biochemical.

This is an important article.

●

For two generations school law in most states has required classroom instruction concerning the effects of alcohol upon the human system. The subject has ordinarily been included in courses in health and hygiene, physiology, and biology.

The laws frequently specify instruction about "alcohol and narcotics" or the "harmful effects of alcohol and other narcotics." Textbook writers have accordingly combined the treatment of alcohol questions with discussions of opiates and their derivatives. Either by direct statement or by implication, students have been allowed to conclude that there is a direct similarity between the pharmacological properties of morphine, heroin, and other opiates, and those of alcohol.

The texts have given emphasis to the individual and social pathology of alcoholism, and have made it appear that the chemical effect of alcohol taken in small amounts differs only in degree from the gross effects of the heavy and sustained drinking of the alcoholic.

Since 1945, concern regarding the public health problem of alcoholism has been expressed in legislative activity at the state level. Twenty-seven states and the district of Columbia are maintaining tax-supported treatment facilities and are conducting research studies in the causation of the disorder.

The alcoholic population constitutes a cross-section of American society. Intelligence, professional competence, family background, social status, economic wealth, occupational skill, and education appear to play a minor role in preventing uncontrolled drinking.

Etiology of the disorder has not been established. There may be some organic dysfunction not yet identified. There is evidence to equate a disposition toward alcoholism with certain psychological characteristics. Yet it cannot be demonstrated conclusively that such traits, either physical or psychological, are specific enough to justify a valid delineation of the "alcoholic personality." Some cultural groups, for example, Southern Europeans and their descendants, appear to have a relatively low rate of alcoholism although their use of alcoholic drinks is general. Among Northern Europeans, the prevalence of uncontrolled drinking among the population is higher than in the South.

The public is beginning to recognize that uncontrolled drinking is a form of illness, an emotional disorder, which affects 6 to 7 per cent of the approximately 67 million adult users of alcoholic beverages in our society. Gradually public opinion is accepting the idea that the pharmacological action of alcohol is not the primary cause of alcoholism.

As this understanding of the nature of alcoholism as an illness has increased, a demand for emphasis on prevention has arisen, and considerable information is being disseminated among adult groups. However, it is expected that public and private school classrooms will offer the most productive soil for long-range prophylaxis.

If the large number of users of alcoholic beverages in our society and the widespread misinformation about the action of alcohol constitute a measure of the effectiveness of the teaching during the last two or three decades, it would appear that some modification in the materials and techniques of instruction is indicated. The textbooks' emphasis on the extreme consequences of heavy drinking and alcoholism apparently has been rejected or ignored by millions of young adults. Perhaps administrators and teachers have been influenced by the elements of propaganda and controversy which characterized textbook and supplementary materials to give only perfunctory attention to the topic.

An objective approach to teaching controversial questions can prevail when the instructor has respect for his materials and confidence in his ability to present them in open discussion. Teaching about alcohol offers no exception to this. Science teachers, because of their disciplined training, are especially qualified to deal with disputed facts about alcohol as well as with conflicting attitudes which revolve around such facts.

Questions about the role of alcohol in our society and problems associated with excessive and uncontrolled drinking do not reside solely in the areas of physiology and biochemistry. Yet, if there were no physical effects from drinking beverages containing alcohol, the practice would have disappeared from general use centuries ago. It is in this area—the metabolism and the physiological effects of alcohol—that a certain amount of misunderstanding exists. Ambiguity in scientific definition and distortion in lay interpretation of many of the facts about alcohol physi-

ology contribute to popular confusion about the issues and retard the development of a well-rounded program of prevention of alcoholism.

Research is slowly clarifying or redefining some of the basic concepts. Science teachers have an opportunity and a responsibility to become acquainted with these developments and to interpret them to students. A specific area in which this responsibility might be discharged is in a study of the relation between alcohol and the opiate drugs in pharmacological classification.

Recently the writer examined four standard biology texts from the lists of reputable school book publishers. The books are widely used in secondary schools. The authors are acknowledged authorities in their fields.

Each of the four authors classifies alcohol as a narcotic drug. Three of the writers associate with alcohol a qualifying word or words which suggest to the reader a reaction of repugnance or fear. For example:

Text A: There is plenty of experimental proof that alcohol, in spite of its being usable in the body for energy release, is a narcotic poison.

Text B: Ethyl alcohol, the narcotic drug in alcoholic beverages, is a waste product of the digestion of sugar by yeast.

Text C: Because alcohol is a narcotic, the consumption of alcoholic liquors is a biological problem . . .

Text D: The common narcotics are opium, chloroform, cocaine, codein, laudanum, heroin, chloral hydrate, alcohol, nicotine, and various patent preparations. These are habit forming drugs.

It is not clear what the writers mean by the label narcotic. If sleep-producing is one characteristic of a narcotic drug, the inclusion of cocaine and nicotine in the list in Text D is difficult to understand.

Certainly a blood alcohol concentration of 0.3-0.4 per cent produces narcosis. But alcohol in different amounts has other effects. It may be characterized, depending on the amount taken, as a sedative, an hypnotic, an analgesic and an anesthetic. Because of its progressive depressant action upon the central nervous system it is more accurate technically to classify alcohol as an anesthetic along with ether and chloroform.

Why do textbooks for secondary students place stress on the narcotic action? Is this primarily the result of oversimplifying complex pharmacology for immature students? Is it an attempt to comply with legislation which antedates present knowledge of the drugs? Is it propaganda designed to discourage the use of alcohol by young people?

There is evidence in the texts quoted that the authors are not fully acquainted with the pharmacological action of alcohol. For example, Text C, after mentioning opium and its derivatives, morphine, codein, and heroin, states

> Like alcohol, their use creates a terrible craving for more and the grip of the habit is much harder to break. Their results are also more serious.

There is no substantial evidence to justify a direct comparison between the action of morphine and alcohol in producing a terrible craving. Millions of people use alcoholic beverages over periods of years without apparent physiological changes. That alcoholics develop a condition which has been labeled "craving" does not justify a generalization about the action of alcohol.

Text D under a chapter heading Habit Forming Drugs and Tobacco states

> The alcohol habit grows similarly to the morphine habit. Although alcohol apparently is not a habit-forming drug to the same degree as opium or morphine, its effect in this respect is different in degree rather than in kind.

Text C reports

> It is important to remember that in the case of poisonous drugs such as strychnine, small prescribed amounts may benefit the nervous system for a time, although larger amounts would be fatal. Similarly, small amounts of alcohol do not produce the same results as do larger amounts . . . some men can drink the equivalent of a quart of whiskey without immediate harm, but such an amount of alcohol might kill a person not accustomed to drinking.

It is unfortunate to associate in the mind of the reader "small amounts of strychnine (prescribed)" and "small amounts of alcohol." More confusing, however, is the introduction of the concept of tissue tolerance for alcohol.

The experienced drinker has learned to adjust, to anticipate the effects of relatively small amounts. There is no evidence to support the statement that cell adaption occurs to the extent that the concentration resulting from ingesting a quart of whiskey will have no effect on an experienced drinker and will be fatal to one less experienced. At a concentration of 0.3 to 0.4 per cent in the blood, every individual becomes stuporous, and his drinking ceases until the blood level of alcohol has decreased to the point where he regains consciousness.

The question of physiological tolerance to drugs is an open one. Much research is needed to clarify and expand our understanding. Goodman and Gilman state:

> One of the most fascinating and difficult fields of pharmacological research is that which deals with the mechanisms of drug action. In a few instances, the fundamental manner in which the drug produces an effect is obvious . . . In the last analysis, too little is known of cellular physiology to permit an interpretation of the mechanism of action of those drugs which alter cellular functions.[1]

That there is an element of inherent tolerance to low concentrations of alcohol among a group of drinkers is apparent. Individual reactions vary widely. That some drinkers develop a kind of functional adaptation to the "fog" created by the anesthetic effects of alcohol can be demonstrated. This adaptation cannot be measured as an anatomic, pathological or morphological change.

Lester defines acquired tolerance as

> the acquisition of a diminished response, as compared to the initial effect, when the substance to which tolerance has been acquired is given repeatedly.[2]

He states further:

> On repeated administration of alcohol, do biochemical alterations appear in such a direction so as to enable the organism to maintain a lower effective concentration of alcohol. Practically, does the human alcoholic metabolize alcohol more completely, does he excrete it more rapidly through the lungs, kidneys, or perspiration than the non-alcoholic? The answer is unequivocal: There are no such alterations in the total metabolism of alcohol.

In the Report on the Second Session of the World Health Organization Expert Committee on Drugs

(Continued on Page 144)

The Catherwood Diatometer,
A New Apparatus for Evaluating Stream Conditions

• **By Matthew H. Hohn, Ph.D.,** *(Cornell University)*
ASSISTANT CURATOR OF LIMNOLOGY, ACADEMY OF NATURAL SCIENCES, PHILADELPHIA, PENNSYLVANIA

The "health" of a river can be judged by the diversity and the number of the different kinds of plants and animals it is able to support. Sewage and industrial wastes reduce the number of non-tolerant species of plants and animals and permit tolerant species to accumulate in large numbers.

Diatoms can be used as a basis for determining the quality of water when a truly representative sample can be obtained.

This article describes an ingenious but simple and accurate apparatus for collecting a representative sample of the diatom flora of a stream. It will probably become widely used.

●

In the summer of 1948, the Limnology Department of the Academy of Natural Sciences of Philadelphia, Pennsylvania, conducted a biological survey of the Conestoga Basin, Lancaster County, Pennsylvania. The purpose of this survey was to determine if the plants and animals living in a stream could serve as a basis for evaluating the condition of the water. The results of this survey (Patrick, 1949) showed that the "health" of a stream can be based on the diversity, the number of different kinds, of plants and animals the stream is able to support. A "healthy" stream is able to support greatly diverse populations of plants and animals with a well rounded distribution of each group. Wherever pollution, sewage or industrial wastes, enters a stream, the resulting detrimental effect tends to reduce the number of non-tolerant species of plants and animals and creates conditions that allow the tolerant forms to accumulate in large numbers. If the pollution is too severe it will eliminate most or all of the population.

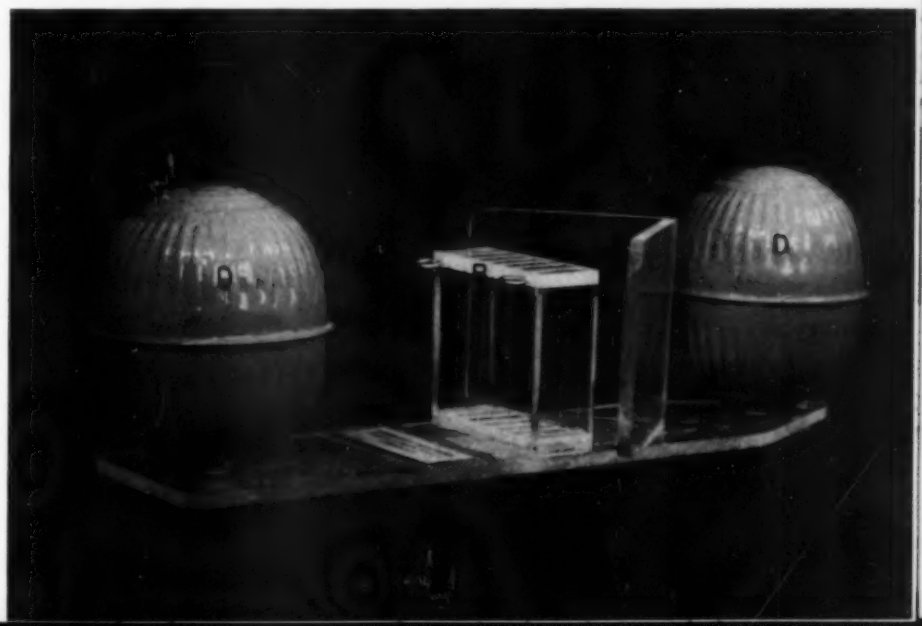
On the basis of this study and subsequent studies conducted at the Academy, it became apparent that it was desirable to develop an apparatus that would be able to collect one or several of these groups of organisms at random and in large numbers. Although several of the groups of plants and animals could be used for a study of this type it was deemed much more desirable to use diatoms. The diatoms were selected because of their small size, universal distribution in large numbers, their rapid growth rate and the ability of the silicon-impregnated cell wall to retain its shape and diagnostic characteristics even when air dried.

Such an apparatus would have to be maintained in the photosynthetic zone of the water at all times. Due to the turbidity and heavy silt load of some rivers, it would have to float. It must also be maintained in deep and shallow water as well as in relatively quiet and in fast flowing streams.

The Catherwood diatometer (Fig. 1) was designed to meet the needs for collecting a random sample of the diatom flora in a river. It is approximately 15 inches long and 4 inches wide. The slide carrier (A) holds six 1 x 3 inch microscope slides in an upright position. This prevents the accumulation of silt from interfering with the growth of the diatoms on the slides. A retaining bar (B) can be loosened by means of two screw "eyes" for removal of the slides. The slides are protected from swift currents or sudden heavy washes by means of a deflector (C). This deflector also helps to orient the diatometer so that it faces into the flow of the current at all times. The diatometer is supported by means of hollow floats (D) that maintain it in the upper layer of water at all times. A lead bar (E) is used to adjust the depth at which the diatometer will float. It may be anchored in position by means of nylon cord fitted through a hole in the nose of the diatometer. The body of the diatometer is made of plastic, a relatively inert transparent material.

The diatometer was placed in Ridley Creek, Chester County, Pennsylvania, a "healthy" stream as determined by a biological survey. Slides were withdrawn at one, two- and four-week intervals. The removed slides were placed in wooden slide boxes and allowed to dry. Subsequent studies have shown that a two-week exposure of the slides in streams of this type gives the best results. This exposure time will undoubtedly vary

FIGURE 1. Catherwood Diatometer.



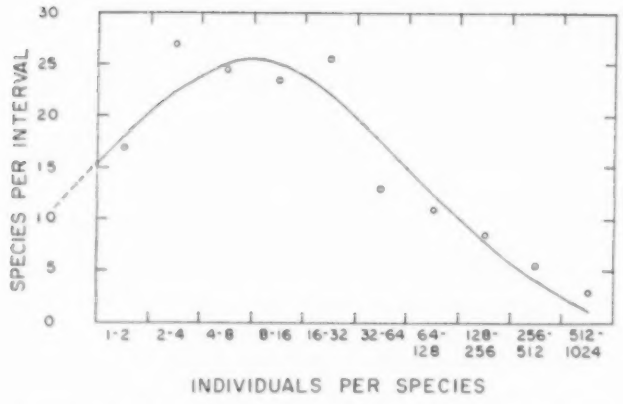


FIGURE 2. Graph of the diatom population of Ridley Creek, Chester County, Pennsylvania, for November, 1951. A "healthy" stream.

depending on the type of stream and the temperature of the water.

Preparation for analyzing the diatom flora collected on the slides was carried out in the following manner. The diatoms were carefully scraped from the slides and cleaned in nitric acid and potassium dichromate. The cleaned diatoms were placed in 20 cc. of distilled water and an aliquot of the mixture removed while the diatoms were apparently uniformly mixed. These were mounted in Hyrax on an 18 x 18 mm. cover slip.

The diatoms were then counted and identified and recorded on a tabulation sheet. From experimentation it was found that it is necessary to count 8,000 specimens to get a reliable picture of the diatom flora in a "healthy" stream such as Ridley Creek.

The tabulated data were analyzed statistically according to the method described by Preston (1948) and Robert Singleton as published by A. Hald (1949). Basically this method involves setting the species down in intervals on a log base. Species represented by 1 - 2 individuals are put in the first interval, 2 - 4 in the second interval, 4 - 8 in the third interval and so on up the scale until all species are included. On this basis the first interval is made up of one-half the species represented by one and two specimens. Since there is as much chance that a species represented by one individual will fall in front of the origin of the curve as in the first interval, one-half species is credited to the first interval. A species represented by two individuals likewise may fall in the first or second interval so that one-half species is credited to each interval. It will be seen that the first interval is made up of one-half the species represented by one and two individuals, while the second interval is made up of one-half the species represented by two and four individuals and all those represented by three individuals. This same procedure applies to the remainder of the intervals.

A decapitated normal curve is then constructed and the observed values plotted against the theoretical values using the number of species per interval as the ordinate and the number of individuals as the abscissa. Such a curve representing the diatom flora of Ridley Creek for November, 1951 is shown in Figure 2. This distribution shows the height of the mode to be 26 species and it falls at the end of the third interval. There are 169 observed species. From the above data it is possible to calculate the number of species present in the theoretical universe of the area being studied. In this area of Ridley Creek this was 185.6 species.

Similar curves constructed for different locations in the same stream or different streams in the same area can be compared with each other. Such a curve (Fig. 3) was constructed for Lititz Creek, Lancaster County, Pennsylvania, for November, 1951, a stream adversely affected by pollution. It is evident from the reduction in the height of the mode to 11.9 species and in the number of observed species to 79 along with a reduction in the theoretical universe to 101 species, that the diatom population was adversely affected by the presence of the pollution. Also the curve covers more intervals, showing the abundance of one tolerant species. In heavily polluted streams no growth of diatoms occurred on slides that were exposed in the water for as long as eight weeks.

Subsequent studies in large rivers, bay areas and coastal canals have shown the same general pattern of the diatom flora. The general shape of the curve was modified depending on the amount and severity of the pollution present.

From an ecological standpoint one of the most important aspects of the diatometer is that a truly representative sample of the diatom flora is accumulated on the slides. At the time the slides were removed from the diatometers in Ridley Creek, a diatomist made thorough collections of the diatoms present in the stream. The average number of species in the collections was 142 and the diatom flora on the slides was represented by an average of 163 species. A total of 116 species were common to the collections secured by these two methods. Between 75 and 85 per cent of the diatoms found in the collections made by a diatomist were also found on the slides removed from the diatometer. When those species represented by eight or more individuals in the two collections were compared, it was found that between 90 and 95 per cent were present in both. Those species that were most

(Continued on Page 148)

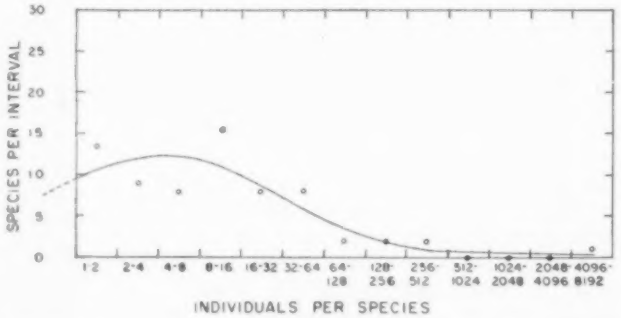


FIGURE 3. Graph of the diatom population of Lititz Creek, Lancaster County, Pennsylvania, for November, 1951. A stream adversely affected by pollution.

The Importance of Magnesium in Human Nutrition

• By **S. Marcovitch, Ph.D.,** *(University of Minnesota)*
UNIVERSITY OF TENNESSEE AGRICULTURAL EXPERIMENT STATION, KNOXVILLE, TENNESSEE

Is the importance of magnesium in nutrition fully appreciated?

The answer appears to be no.

This paper points out the dangers of a deficiency of this element in human and animal feeding, and the necessity for supplemental quantities to prevent the possible development of a series of degenerative and functional disturbances.

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Our well-being depends primarily upon our food, which is composed of proteins, fats, carbohydrates, minerals, and vitamins. The importance of vitamins has been emphasized in recent years, but the minerals seem to have been neglected, particularly magnesium.

We know that we need calcium for bones, iron for the red blood cells, and iodine for good thyroid action, but it is generally taken for granted that magnesium occurs abundantly enough in our foods that we can forget about it. This neglect of the importance of magnesium in nutrition has been an error. Its study has lagged far behind that of the other inorganic elements.

A deficiency of magnesium, particularly for the adult, is not readily detected, but over a period of several decades it may bring about a host of degenerative and functional disturbances that do not spell well-being or buoyant health.

The widespread use of salts as purgatives and the popularity of the mineral waters and spas are due in most instances to the presence of magnesium salts, and with the great Sir William Osler, magnesium sulfate was the purgative of choice. Because salts are associated with purgatives in the minds of most people, and because the frequent use of purgatives is frowned upon, the importance of supplemental quantities of magnesium in small amounts is not understood. If, however, it can be shown that our diet is often lacking in available magnesium, then supplemental quantities will be looked upon as a benefit. Milk, for example, although an excellent food, has a paucity of magnesium. A diet composed of refined foods, even though it contains milk, will be short of magnesium and over the years with many people it may bring on an obscure train of symptoms, such as arthritis, constipation and certain degenerative diseases.

The Physiology and Biochemistry of Magnesium

Although magnesium has been known to be an essential element for chlorophyll for nutrition in plants, it was not until 1932 that it was demonstrated by Kruse, Orewt, and McCollum to be essential for human nutrition. They were able to prepare a diet with as little as 0.18 mg. of Mg per 100 gm. of food. Upon such a diet rats become hyperexcitable, develop circulatory disturbances, edema, and soon die of convulsions. There is also a failing fat metabolism, with fat clots and with a greatly increased cholesterol content of the blood—up to 276 mg. per 100 cc., whereas the normals were 152 mg./100 cc. The magnesium-deficient rats show a low blood Mg of .45 mg./100 cc. The normals had 1.6 to 2 mg./100 cc.

Tufts and Greenberg found that on a low magnesium diet, there is a loss of appetite and the kidneys of rats show marked degenerative changes with a 15-fold increase in calcium. Calcium is increased in the heart from 50 to 100 per cent.

In animal nutrition, Duncan, Huffman, and Robinson were able to produce an experimental magnesium deficiency in calves on a diet of whole milk supplemented with Fe, Cu, Mn, Si, Al, and cod liver oil. After a month or two on this milk diet, tetany developed and many of the animals died. The blood magnesium was low, 0.88 to 1.5 mg./100 cc. of plasma. This diet had a magnesium content 55 times as high as that of the McCollum diet. Another disease of cows known as grass tetany shows all the symptoms of magnesium deficiency with a very low blood Mg (Sjollema and Seekles, 1930).

No definite human pathology has yet been demonstrated to be due to magnesium deficiency, but the nature of its metabolic role is obscure. That clinical manifestations may be present is shown by the work of Hirschfelder (1934) who found a low blood magnesium of 1 mg. in patients on a soft diet with milk. These patients showed hyperirritability with twitchings. When given 25 gm. of magnesium sulfate, the blood Mg rose to 4 mg. and the twitchings stopped.

The requirement of magnesium in human nutrition is not known. H. C. Sherman found in 150 American dietaries a variation of 0.14 gm. to 1.2 gm. with an average of 0.67 gm. Most diets will average 0.27 gm. Daniels and Everson (1936) recommend for children 13 mg. per kg. of body weight. For an adult weighing 70 kg. this would come to 0.91 gm. If this amount should be required, then diets furnishing a minimum of 0.14 gm. of magnesium could be considered to be deficient. Good food sources of magnesium are vegetables, nuts, dried peas, beans, and wheat germ.

Most magnesium is stored in the bones. In cells, magnesium is present in far greater concentration than calcium. This is true also of sea water. Magnesium is known to be a carrier of phosphorous and proteins. It activates certain phosphorlytic enzyme systems concerned with carbohydrate metabolism.

Ion Antagonism and Its Relation to Permeability

The classical studies in the field of ion antagonism were performed by Loeb who showed that a pure potassium chloride solution is toxic to the minnow *Fundulus*. The addition of sodium chloride to the potassium chloride will remove the toxicity. This is known as ion antagonism, which in turn controls permeability or the selectivity of the passage of electrolytes and water across living membranes.

In the same way Ringer noted that the excised heart will stop beating in pure isotonic sodium chloride, and that traces of calcium will neutralize the poisonous effects of the sodium. Other bivalent ions such as magnesium can be substituted for the calcium.

Meltzer and Auer showed that magnesium sulfate acts as an anesthetic when administered subcutaneously to rabbits. The animal can, however, be restored to full consciousness by the injection of calcium chloride. We have the fact then that both calcium and magnesium act antagonistically to sodium, and also act antagonistically to one another.

It is a curious fact that the subject of ion antagonism seems to have its counterpart in soils, as well as in plant physiology. In soils the subject of base exchange shows that sodium may be replaced by calcium, calcium by sodium, potassium by calcium, and sodium by magnesium.

MacCallum showed that 10 cc. doses of sodium citrate, sulfate, or tartarate produced pronounced purgation when injected subcutaneously in rabbits. Application of calcium chloride or magnesium chloride inhibited these effects. It seems that the stimulating action of the purgative salts is due to displacement of calcium and consequent irritability.

Mathews and Austin showed that dogs with hypercalcemias tolerated larger doses of magnesium sulfate. The dogs with hypercalcemia induced by parathyroid hormone showed a marked contraction of the blood vessels, higher blood pressure, and irregular heart beat. The magnesium injections cause a dilation of the blood vessels.

Hirschfelder and Serles in order to account for the antagonistic action of magnesium and calcium, showed that magnesium salts tend to increase the water-in-oil phase of the surface layer of cells more than do calcium salts. The increase in the water-in-oil phase favors the anesthetic and analgesic states. It is likely that the soporific drugs and coal tar analgesics tend to produce water in oil emulsions in the surface layer of nerves, thus diminishing ionic interchange between the interior and exterior nerve cells. This seems to furnish an explanation of the mode of action of analgesic drugs.

Claude Bernard long ago gave us the conception of the organism as a dynamic equilibrium in control of its environment, adjusting and regulating within narrow limits such "conditions of life" as osmotic pressure, hydrogen ion concentration, temperature, sugar content, calcium, potassium, and a thousand other elements yet to be discovered "in the internal environment." Gross internal variations undermined the ability "to concentrate, to think logically, to pay attention."

Calcium and Magnesium in Foods and Tissues

A table has been prepared showing both the calcium and magnesium content of human tissues and of foods together with the magnesium-calcium ratio. A glance at the table indicates the same general ratios in tissues, organs, and foods.

Among the tissues and organs, the highest magnesium-calcium ratio is found in striated muscle which has to do with movement. The heart muscle has also a high ratio. Cartilage has a high magnesium content which probably enables it to withstand the shocks of movement. Bones, on the other hand, which are used for support are composed largely of calcium and have the lowest ratio.

It is also noteworthy that such an important organ as the liver has a high magnesium ratio, as do also the brain and the kidney. The blood and the ductless glands, such as the adrenals, thyroid and pancreas, have a low ratio.

Looking over the foods, it is noticeable that milk and cheese have low ratios, comparable to bones. Their high calcium content is the primary source for the formation of bones. Oranges, cabbage, carrots and greens such as kale and turnips are fairly high in calcium. Among the highest magnesium-calcium ratios are the grains, bananas, and meats.

The problem arises as to the best means of preventing calcification which inevitably comes with the aging process. Many factors are involved, such as the hyperactivity of the parathyroids or the underfunctioning of the thyroids and the character of the diet. Since magnesium is capable of antagonizing calcium, the magnesium-calcium ratio is worthy of study.

If this is the case, milk with a low magnesium ratio, while an excellent food for the young, may be detrimental for adults. Better would be such foods as grains, meats and bananas which have a high magnesium ratio.

Clinical Studies

Recent clinical studies have shown magnesium gluconate to be of value in the treatment of eclampsia

Percentage Composition of Representative Foods of Calcium and Magnesium

1. Those with a high ratio of magnesium to calcium

Food	Magnesium	Calcium	Mg./Ca. ratio
Cashew nuts	.27	.05	5
Corn	.033	.006	5
Banana	.032	.008	4
Wheat germ	.34	.08	4
Wheat bran	.59	.14	4
Wheat (whole)	.135	.04	3
Rice (whole)	.03	.01	3
Peanuts	.18	.067	2.4
Meat	.11	.06	2

2. Intermediate

Potatoes	.028	.013	2
Sweet potatoes	.028	.02	1.4
Raisins	.083	.06	1.4
Pecans	.15	.08	2
Tomato	.01	.007	1.4
Peas	.034	.023	1.5
Apples	.007	.008	1.2

(Continued on Page 146)

Not Chalk and Talk

• **By Lydia Bourne Walsh**
PROFESSOR OF BOTANY, CHAIRMAN, DIVISION OF NATURAL SCIENCES, ELMIRA COLLEGE, ELMIRA, N. Y.

To most science teachers comes sooner or later the necessity for staging an open-house, a parents' night, or an exhibit of some kind.

Here is a helpful account of a successful biology exhibition arranged by college students for a group of science teachers. It offers many useful suggestions.

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At the request of the New York State Science Teachers' Association—Southern Zone, the teaching staff and major students of the biology department, Elmira College, Elmira, New York, demonstrated laboratory exercises for the afternoon program of the association's annual fall meeting. The purpose was to present to the visiting high school teachers suggestions for their own laboratory instruction, science projects, or school science clubs. Student hostesses greeted the guests at the door of Carnegie Science Hall. There each guest received a program which listed the titles of the demonstrations, grouped by room numbers, and the name of the student in charge of every one or two demonstrations. The student was responsible for answering questions on the demonstration, keeping it in working order and, in some cases, was actually performing the demonstration before the guests. The demonstrations on a given branch of biology were near together in the same room.

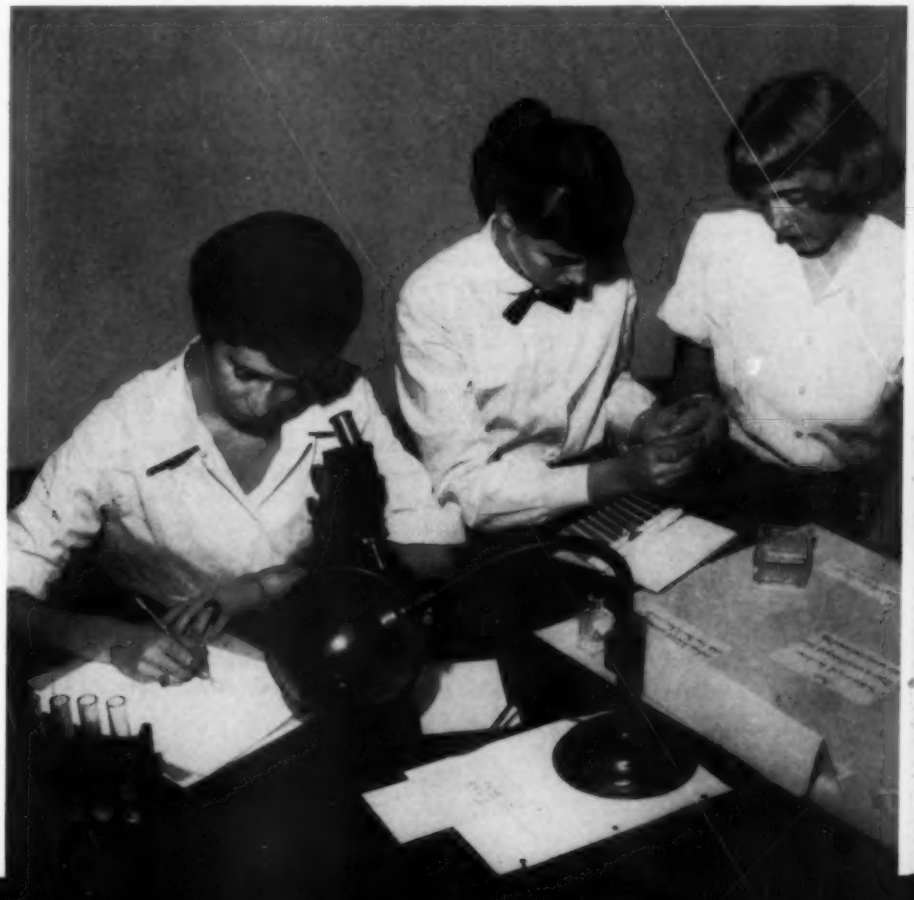
In the section on microtechnique a guest watched a student take a drop of blood from the finger of another student or guest volunteer, make a blood smear, stain it and place it on the microscope for observation. In this same section students made permanent mounts of stained, free-hand, cross sections of pith of elderberry stem, *Tradescantia*, corn, geranium, and coleus. Procedures for permanent stained mounts of onion epidermis, filamentous green alga, bread mold, and macerated wood from a match stick or tooth pick were also demonstrated.

Visitors interested in natural history or in the use of field trips in biological instruction saw fossils found locally, a diorama of a habitat group made by students, a collection of birds' nests, salamanders, and a demonstration of the mounting of insects. There were two aquaria, a fresh water balanced aquarium and a marine aquarium. The salt water and marine invertebrates were obtained from a marine biological laboratory and although not permanent, this demonstration showed that a marine aquarium can be kept in good condition for several weeks inland. The guests saw a chart for recording birds seen on field trips and heard records of bird songs. To call to mind the botanical side of a field trip there was a demonstration of the preparation of an herbarium specimen. A vasculum, plants, plant press, glass plate, glue, and mounted specimens were on view.

Genetics was represented by parents, F_1 and F_2 generations of *Drosophila*, and the F_2 generation of green x albino sorghum. The living fruit flies were mounted between two large glass slides, held one above the other by a roll of paper at each end and sealed on the four sides with tape. The green and albino sorghum was growing in a flat. Embryology was represented by a series of stages of chick embryos seen in the eggs through windows, a living embryo in saline solution and permanent whole mounts of chick embryos. There were museum jars of whole mounts of goldfish, rats, and chicks in which the flesh had been cleared and the bones stained.

The demonstrations in physiology offered the guest something to do and something to see. He could

ELMIRA COLLEGE students in biology demonstrating how to make a blood smear for visiting high school teachers.



measure his own vital capacity with a spirometer, listen to muscle sounds through a stethoscope, observe circulation in the foot of a live frog, or Brownian movement from a microscopic mount of India ink in water, or streaming cytoplasm in *Elodea*. Other demonstrations in this physiology section showed gas formation in a fermentation tube by yeasts growing in sugar solution, and osmosis when the membrane, that of an egg, is a closed one. A geranium plant from which the leafy stem had been cut and to which a glass tube had been connected by a small piece of rubber tubing showed the absorption of water by a root. Two students made tests for starch, glucose, fat, and protein on beans, corn, potato, and onion. Another student demonstrated the digestion of starch by diastase and by saliva.

On a laboratory table were fruits such as tomato, orange, grape, banana, cucumber, olive, sunflower, wheat, corn, pea pod, and poppy capsule, labeled and arranged in groups to show types of fruits. This exhibition was attractive in appearance.

There were two very simple demonstration experiments on soil. One showed the amount of air in soil and the other the water-holding capacity of three types of soil, gravel, garden loam, and sand. A known amount of water was filtered through each soil and the filtrate measured. In addition root systems growing in soil could be seen through glass-sided boxes. These demonstrations were suggested for use in connection with the study of soil erosion.

Some of the laboratory exercises on health would be troublesome for a high school teacher to perform with his class unless he had facilities for sterilizing nutrient agar and petri dishes. There were petri dishes of sterile nutrient agar on each of which had been placed some object. A penny, a dime, a dollar bill, a cat's hair, a housefly, pencil, human hair, postage stamp, telephone mouthpiece, doorknob, and a kiss. There was little or no growth of bacteria or of fungi on the agar near the penny, dime, imprint of telephone mouthpiece, doorknob, and kiss and considerable growth on the agar near the other objects. A second demonstration in the subject of health was rather dramatic. It showed the removal of a colored bacterium *(Serratia marcescens)* from the hands by washing in different ways. A student had dipped her finger tips in a suspension of this harmless colored bacterium, washed her hands in one of four ways and touched her finger tips on agar. After washing in cold water without soap or a nail brush there were enough cells of *Serratia marcescens* left to make five finger tip growths on the agar. With the application of hot running water, soap, and a nail brush fewer and smaller growths of the colored bacterium grew on the agar from the finger tip imprints but some skin bacteria that were brought to the surface by the scrubbing grew on the plates. A third demonstration in health and one that would not require an autoclave or an oven for sterilizing the media and glassware was done with milk. This showed the effect of sterilization, pasteurization, and storage temperature upon milk. Sets of tubes of raw skim milk in clean, not sterilized, test tubes without treatment, after pasteurization, and after heating in boiling water for twenty minutes had been put in the refrigerator, laboratory locker, and incubator. This was a very simple experiment that gave clear cut results and had important application to public health.

Student-made models in colored clay of mitosis and meiosis were on display as a suggestion for variety in laboratory work. These were made after microscopic study and drawing of the phases. There was also a large clay model of a dissected earthworm. This had been made after the student had dissected the earthworm and identified the organs.

For anyone interested in both plants and in drawing there were colored renderings and planting plans of simple, but practical garden designs. There was a design for the entrance to a private property, the foundation planting of a small house, and an outdoor living room.

The foregoing is a description of the laboratory exhibits presented to the New York State Science Teachers' Association—Southern Zone. It is noted that some showed the results only, but wherever possible, the demonstrations were "live ones", that is, the students were actually doing laboratory work when the visitors came in. In addition detailed, mimeographed instructions were available for the guests to take away with them. Thus the guests had something more tangible than a "chalk and talk" program for their meeting. ●

LABORATORY DEMONSTRATIONS IN BIOLOGY

FIELD TRIPS

1. Collection of fossils.
2. Recording birds seen.
3. Habitat study (a diorama).
4. Salamanders for vivarium.
5. Records of bird songs.
6. Collection of bird nests.
7. Insect demonstration.

AQUARIA

1. Balanced fresh water aquarium with guppies.
2. Marine aquarium.

GENETICS

1. Drosophila, parent generation; F1 generation; F2 generation.
2. Sorghum, F2 generation of green x albino.

PERMANENT MICROSCOPIC MOUNTS MADE WITHOUT A MICROTOME

1. Blood smears.
2. Free hand sections of elderberry pith.
3. Mounts of onion epidermis.
4. Mounts of algae and fungi.
5. Maceration of wood.
6. Free-hand sections of herbaceous stems.

EMBRYOLOGY

1. Stages in development of chick.
2. Whole mount of chick.

PHYSIOLOGY

1. Spirometer for vital capacity.
2. Streaming cytoplasm in *Elodea*.
3. Microscopic mount of India ink and water to demonstrate Brownian movement.
4. Gas formation by yeasts growing in sugar solution in a fermentation tube.
5. Muscle sounds heard with stethoscope.
6. Circulation in foot of live frog.
7. Tests for starch, fat, glucose, protein on beans, corn, potato, and onion.
8. Digestion of starch.
9. Absorption of water by root.
10. Osmosis when membrane is a closed one (egg).
11. Effect of cuticle (apple) and bark (potato) upon rate of transpiration.

(Continued on Page 149)

Launderometric Evaluation of Some Cellulose Derivatives

• By **J. V. Karabinos, Ph.D.,** (*Ohio State University*)
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Since sodium carboxymethylcellulose has proved to be a valuable additive to detergent mixtures, it seemed possible that other cellulose derivatives might be useful in a similar way.

So a number of derivatives were synthesized and tested.

Here are the results.

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Water-soluble polymeric materials such as gums, starches, proteins and cellulose derivatives have been widely recommended as organic additives to built detergent mixtures[1]. These substances presumably enhance the detergency of such mixtures by improving their soil-suspending characteristics. Of the above mentioned organic builders, sodium carboxymethylcellulose (I) has received widest recognition[2]

Cell — O — CH_2COONa (I)

in this field and is now being incorporated into most detergent mixtures. The behavior of this derivative in detergent solutions has been discussed by Nieuwenhuis[3] who postulated that the cellulosic portion of the molecule is adsorbed by the cotton fabric while the charged carboxymethyl groups projecting from cloth serve to repel the dirt particles. A launderometric procedure for the evaluation of carboxymethylcellulose activity based on a whiteness retention[4] assay has been described[5]. It therefore seemed desirable to apply this analytical technique to the evaluation of various other cellulose derivatives in order to ascertain the specificity, if any, of the carboxymethylcellulose molecule.

For this purpose, various cellulose derivatives were synthesized including the cellulose sulfates, hydroxyethylcellulose, and oxycelluloses. Each of these substances (90 mg.) was evaluated according to the previously described[5] test method using Ultrawet 30-DS as the anionic detergent at a pH of 10. Table 1 shows the percent reflectance obtained in each case in comparison with a determination using a commercial sample of sodium carboxymethylcellulose and including a blank determination. This table likewise indicates reaction conditions and yields of the various cellulose derivatives using Hercules cotton linters. In most cases the water-soluble cellulose derivatives were isolated by precipitation from ethanol with subsequent drying of the product.

Discussion of Results

From the results secured in Table 1 it becomes evident that the launderometric activity of carboxymethylcellulose is indeed quite specific. For optimum activity, the presence of a dirt-repelling ionic group such as sodium carboxymethyl is essential. On the other hand, this group apparently cannot be replaced

(Continued on Page 156)

TABLE 1

Preparation and Launderometric Evaluation of Cellulose Derivatives

No.	Wt. Cellulose	Reagents and Conditions	Yield in grams	% Reflectance
1.	1.62 g.	1.58 g. $KMnO_4$ + 50 ml. water (24 hours)	2.7	25
2.	1.62 g.	5 ml. of 30% H_2O_2 + 50 ml. water (24 hours)	1.8	22
3.	1.62 g.	1.14 g. H_5IO_6 + 50 ml. H_2O (24 hours)	1.8	29
4.	1.62 g	2.28 g. H_5IO_6 + 50 ml. H_2O (24 hours)	1.9	28
5.	1.62 g.	4.56 g. H_5IO_6 + 50 ml. H_2O (24 hours)	1.9	25
6.	2.51 g.	Passed in ozone for 64 hours	2.45	22
7.	1.62 g.	1 ml. of conc. NaOCl (16% Cl) + 50 ml. H_2O (24 hours)	1.7	23
8.	1.62 g.	5 ml. of conc. NaOCl + 50 ml. H_2O (24 hours)	1.7	24
9.	10 g.	8.4 ml. N_2O_4 (24 hours) removed 1 g.		33
10.	9 g. (#9)	8.4 ml. N_2O_4 (24 hours) removed 1 g.		29
11.	8 g. (#10)	8.4 ml. N_2O_4 (24 hours) removed 1 g.		26
12.	7 g. (#11)	8.4 ml. N_2O_4 (96 hours) removed 1 g.		25
13.	6 g. (#12)	8.4 ml. N_2O_4 (120 hours) removed 1 g.		20
14.	1.8 g.	0.33 cc chlorosulfonic acid + 50 ml. pyridine (24 hours)	0.55	18
15.	1.8 g.	0.65 cc chlorosulfonic acid + 50 ml. pyridine (24 hours)	1.55	19
16.	1.8 g.	1.3 cc chlorosulfonic acid + 50 ml. pyridine (24 hours)	2.22	19
17.	5 g.	50 ml. 80% H_2SO_4 + 50 ml. 80% HNO_3 (24 hours)	6.7	29
18.	5 g.	50 ml. 75% H_2SO_4 + 50 ml. 50% HNO_3 (24 hours)	1.9	21
19.	1.62 g.	1 g. Succinic Anhydride + 30 ml. pyridine (4 days @ 60° C)	2.5	17
20.	1.62 g.	2 g. Succinic Anhydride + 30 ml. pyridine (4 days @ 60° C)	3.8	23
21.	1.62 g.	3 g. Succinic Anhydride + 30 ml. pyridine (4 days @ 60° C)	5.3	19
22.	1.62 g.	2 g. Maleic Anhydride + 40 ml. pyridine (4 days @ 60° C)	3.7	16
23.	2.5 g.	Converted to Na cellulose + 1.6 cc Allylchloride (24 hours)	3.5	28
24.	162. g.	Shredded with 210 cc H_2O + 50 g. NaOH + 145 g. sodium chloroacetate (6 hours) and stored for 2 days	350	45
25.		Commercial hydroxyethylcellulose		18
26		Commercial carboxymethylcellulose (0.7 degree of substitution)		48
27.		#25 purified by precipitation from ethanol under acidic conditions		56
28.		Blank (no cellulose derivative added)		20–23

Ultrasonics . . . *A Physical Tool for Biological Research*

• By Nelson H. Newton
FORMERLY, BATTELLE MEMORIAL INSTITUTE, COLUMBUS, OHIO

This stimulating paper directs attention to one of the newest and most promising techniques of biological research. Physicists and electrical engineers have joined with biologists in the study of the effects of ultrasonic energy on living matter. The results they have obtained are extremely interesting.

Various cellular constituents have been released and extracted. Certain non-spore-bearing bacteria have been killed by the use of intense sound fields. High molecular weight polymers have been broken into smaller molecules. Other notable effects are here reported.

This is an important article.

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One of the most significant recent trends in biological research has been the application of the disciplines and techniques of physics and physical chemistry to the solution of biological problems. Such applications have proved extremely fruitful in many instances and have resulted in a new field of science generally designated as "Biophysics." Such tools as the ultracentrifuge and electrophoresis apparatus are two of the most useful and essential instruments used in biophysical studies for obtaining quantitative information regarding the physical and physiochemical properties of living matter.

More recently considerable and increasing interest has centered on studies relative to the effects of sound fields on biological systems. Such studies are, strictly speaking, biophysical and involve the application of physical and electrical-engineering knowledge and training to the problems and interests of the biologist.

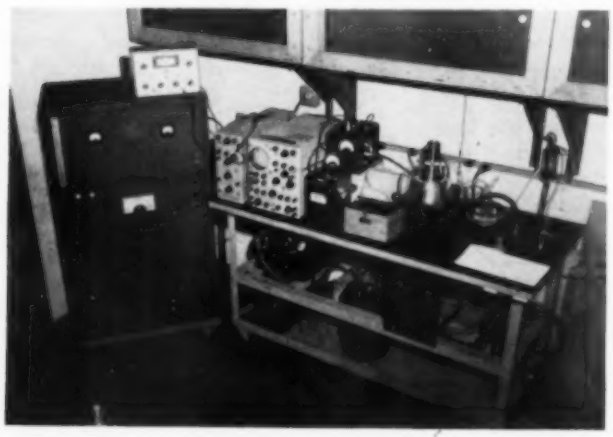

FIGURE 1. Ultrasonic equipment especially designed and constructed for use in biological investigations.

Investigations of the effects of sonic and ultrasonic energy on living matter began about thirty years ago, but only since the end of World War II have intensive efforts been made in this direction. The term sonic includes all vibrational frequencies up to the limit of the audible human range, 20,000 cycles per second. All sound vibrations whose frequency is greater than this value are termed ultrasonic. At present, there is a comparatively large amount of literature reporting the effects of sound fields on biological matter. In most instances sonic or ultrasonic energy has been used to destroy, disintegrate, or extract various biological entities or substances. Through its application it has been found possible to destroy or inactivate some bacteria and viruses, release enzymes and antigens from cellular material, and produce marked changes in the viscosity and particle size of cellular suspensions.

There are certain advantages over the ordinary methods of grinding and blending in the use of sound for dispersing, deagglomerating, and extracting biological components. In the latter processes, mechanical contact between the grinding or blending surfaces and the biological material are requisite. The application of sound fields for the same or similar purposes does not involve such mechanical contact. Particularly in the case of the more labile proteins, as for instance some enzymes, antigens, and similar substances, ordinary grinding, ball milling, and blending cannot be tolerated without subsequent denaturation.

Complex factors are involved in the use of sound energy for obtaining desirable products, such as intact cell-free antigens and enzymes. In spite of the ever-increasing efforts in this branch of biophysics, there is at present considerable confusion regarding the effects of sonic and ultrasonic energy on biological material. This situation stems from two sources. On the one hand, any study and control of the forces and factors associated with the generation of sound waves is complex and outside the field of training of biologists. On the other hand, measurement of certain physical and electrical factors is in itself difficult, or the methods for measuring are limited in their present development. To obtain reliable information from ultrasonic biological research, close cooperation between physicists, biologists, and electrical engineers is requisite.

One of the most difficult problems in applying sound to biological systems centers around the necessity, in many cases, for reproducing desired effects on a quantitative or semiquantitative basis. The problem, together with the difficulty of adequately controlling the heat generated in biological material during exposure to high-intensity sound fields, has necessitated considerable effort and research. There does not appear to be any sonic or ultrasonic commercial equipment available which is entirely adequate in both these respects. It is, therefore, necessary for the investigator to modify existing commercial equipment or to construct

suitable equipment if reproducible quantitative results are desired.

Practically all biophysical studies with sound employ magnetostriction or piezoelectric elements for the generation of sound waves. In either case, electrical energy is converted to mechanical energy which is propagated in liquid media. All the effects of sound waves reported in this review were obtained with piezoelectric materials. Application of electrical power to some substances causes them to vibrate or oscillate, owing to certain physical properties of the material. Substances which exhibit this phenomenon are said to have piezoelectric properties. Only two piezoelectric substances are of practical importance in biophysical research; these are quartz and barium titanate, both of which have been used in the present studies.

Considerable effort at Battelle Memorial Institute has been devoted to the design and construction of equipment suitable for producing quantitative reproducible results with intense high-frequency sound fields. Special attention has also been given to the development of accessory cooling equipment so that biological materials are not subjected to excessive amounts of heat during their exposure to ultrasonic vibrations.

It is generally agreed that many of the effects resulting from the exposure of materials to sound fields are directly or indirectly due to a phenomenon known as cavitation. Cavitation is caused by rupture of liquids or liquid suspensions in sound fields and occurs when the pressure amplitude becomes sufficiently great. During cavitation, gases dissolved in liquids (generally water) partially fill the voids created by rupture of the liquid molecules. The implosion of such cavities and the fantastically high accelerations of the imploding liquid molecules seem to be responsible for the rupture and disintegration of solid or semisolid particles suspended in the liquid medium.

Applications of Ultrasonic Energy

Numerous biological substances have been exposed to sound fields in the investigations undertaken at Battelle Institute.

In early studies, tobacco mosaic virus was exposed to sound waves oscillating at a frequency of seven million cycles per second. The fundamental unit of tobacco mosaic virus is 280 mμ long. This is the basic infectious unit. The virus is able, through physical forces, to produce linear aggregates composed of two or several basic infectious units. By careful exposure of these aggregate forms of the virus to various intensities of ultrasonic energy, it was possible to show that these forms of the virus are weakest at the points of linear aggregation. Additional research suggested that the virus basic unit was weakest at a point 175 to 205 mμ from one end.

Exposure of the virus to very intense sound fields resulted in the production of fragments one-tenth to one-eleventh the length of the basic unit. The serology of the fragmented material showed that, in spite of the severe ultrasonic treatment, antigenic capacity and specificity were maintained while infectivity was reduced 95 per cent (Newton, 1951; Newton and Kissel, 1953).

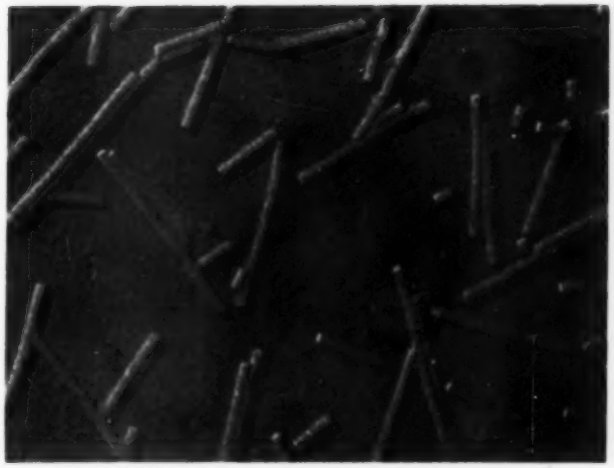

FIGURE 2. Tobacco mosaic virus shadowed with platinum at an angle of 12°, 100,000 X.

The serology and immunology of ultrasonically disintegrated tobacco mosaic virus suggested the feasibility of using sound energy for the extraction of intact antigens from microorganisms.

In many infectious diseases, such as tuberculosis and syphilis, knowledge of acquired resistance and procedures for immunization are dependent on the isolation and detection of unknown antigenic complexes in the bacterial cells. Such substances, and antibodies for them, are not demonstrable with intact cells. Various attempts to extract these substances by physical, chemical, and enzymatic digestion processes have failed, probably due to modification or destruction of labile protein components by the extracting agents, or to the presence of antigens only in minute quantities. The application of ultrasonic energy for the liberation of such antigens has been successful in yielding extracts containing antigens which were not demonstrable by other means.

Large masses of the Reiter spirochete were exposed to sound fields. This organism is closely related to the virulent one which causes syphilis. A protein fraction appreciably larger than obtained by other methods precipitated from the ultrasonic extract of this organism. Subsequent electrophoretic procedures demonstrated protein and lipoprotein complexes not detectable in extracts prepared by other methods. Immunologic study revealed that the antigenic capacity and specificity of these complexes was not affected adversely. It is quite probable that one of these lipoproteins represents the unmodified Wassermann antigen complex. If this is the case, the Wassermann test for syphilis should be made more specific by the use of this antigen. Possibly false positive reactions in syphilis diagnosis, which sometimes have very serious social consequences, would be eliminated.

Similar results have been achieved with *Mycobacterium tuberculosis* extracts produced by ultrasonic

treatment. It has been possible to produce a separation of antigenic components, and such extracts have shown that an as yet unknown antibody exists in the sera of tuberculous persons and animals.

In a study conducted with an egg-adapted strain of influenza virus (PR8), it was observed that liberation of virus from chorio-allantoic membranes could be achieved within one minute. The quantity of virus freed from tissue was equal to that obtained by manual grinding for five minutes. By carefully altering acoustic intensities and temperature, it was possible to decrease the infectivity of partially purified virus without altering its hemagglutinability. In these studies of influenza virus, immunologic tests have demonstrated that the antigenic capacity and specificity of the virus were not modified by various types of ultrasonic treatment.

Coupled with the fact that the use of sound fields offers a means of extracting antigens from microorganisms in the intact, undenatured form, a second advantage arises from this method for the production of vaccines. Since after separation of the antigens from the organism the latter can be removed by centrifugation, a large portion of the nonspecific protein material is thereby eliminated. Vaccines prepared in this fashion would, therefore, have a low nitrogen content and would be expected to produce a minimum of adverse side reactions such as allergic manifestations following injection into the body.

In addition to the promising results evidenced by the ultrasonic extraction of antigenic components from microorganisms, other useful applications of ultrasonic energy to biological substances have been shown.

Through the use of intense sound fields, it is possible to rapidly kill certain of the nonspore-forming bacteria. One nonspore former was completely inactivated after exposure to sound for thirty minutes under carefully controlled conditions as regards temperature and ultrasonic power. The rate of kill was found to be highly dependent on temperature as well as power intensity. Changes of a few degrees produced a marked increase or decrease in the rate at which the organisms were killed. In the case of (at least) one other type of spore-forming bacillus, the lethal effect of high-intensity sound was much less. Employing intense ultrasonic vibrations and maintaining the temperature constant at 32 C. the nonspore-forming bacterium was completely killed in thirty minutes, 99.97 per cent of the organism having been destroyed in fifteen minutes. Under the same conditions, only a 30 per cent reduction in the viability of the spore-forming organism was effected.

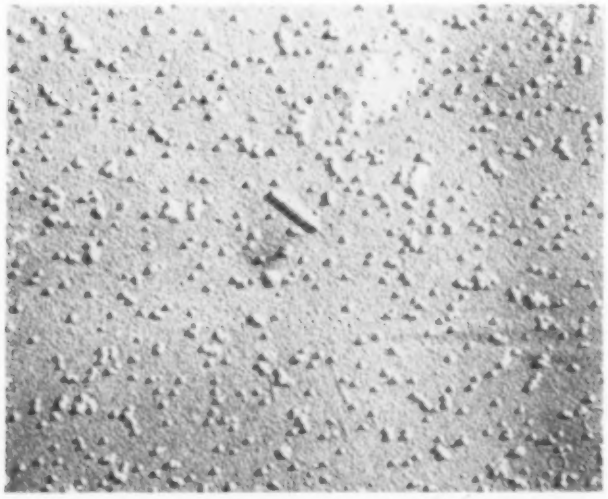

FIGURE 3. Tobacco mosaic virus following exposure to high-intensity ultrasonic vibrations; shadowed with platinum at an angle of 12°, 48,600 X.

These results suggest that, where contamination in liquid suspensions or solutions is due to nonspore-forming bacteria, it may be possible to sterilize by sound. From a commercial standpoint, however, there are many limitations to the use of sound for sterilization. Chief among these is the high cost involved, which limits or prohibits the use of sound fields for decontamination. Exceptions may exist in certain instances such as the pharmaceutical industry, where the costs could be tolerated.

Sound also has a definite effect on the physical properties of pharmaceutical materials. Polyvinylpyrrolidone has been exposed to high-intensity sound fields, This substance was used by the Germans as a blood extender during World War II and since has been used for numerous purposes. It is a high-molecular-weight polymer. Exposure of this substance to sound fields resulted in a progressive decrease in its viscosity with time, indicating that the material was broken into smaller molecules. Polyvinylpyrrolidone is manufactured in a variety of molecular weights or sizes. Its use for certain purposes, particularly as a blood extender and drug, necessitates that it be of the proper molecular weight. Since it is possible to control conditions carefully during exposure to sound, this technique might be used to produce polyvinylpyrrolidone of any desired molecular weight or viscosity.

An example of the application of sound to fundamental or basic scientific problems is the use of this energy to liberate chromosomes from avian erythrocytes. It was found that high-intensity ultrasonic vibration released a greater quantity of intact chromosomes from turkey red blood cells than did Waring blending, grinding, or freezing with liquid nitrogen. After liberation of the chromosomes, the ruptured erythrocytes could be removed by centrifugation, and basic studies regarding location of certain chromosome constituents was possible.

As indicated by the studies reviewed above, the use of sound fields in pure and applied biology has a real potential.

Through the selective use of sonic and ultrasonic power, one has at hand an instrument capable of releasing various cellular constituents from biological materials. At the lower power levels, exotoxins, surface antigens, and other outer cellular materials may be liberated. With the application of increasing vibrational amplitude, cellular material may be ruptured

(Continued on Page 155)

Modern Trends in High School Chemistry

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What qualities should a high school teacher of chemistry possess in order to make him an unusually successful instructor, as evidenced by the later success of his pupils? What are the most significant trends in today's teaching?

This factual article, based on personal interviews and ideas expressed in published articles, evaluates certain theories, methods and approaches. You will enjoy reading it. You will be benefited by it.

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Generally speaking, students of high school chemistry may be divided into two classes: future chemists and non-chemists. The future chemist represents a very small per cent of the class; yet he will play a very important role in America's future. The non-chemist—the future statesman, legislator, business man or housewife, —represents a very large per cent of the class. To a proportional degree, he will develop America's future in the teaching of chemistry. Both groups must be considered. We shall keep both groups in mind as we attempt to interpret modern trends.

What of that elite group—the future chemists?

Last year the Pittsburgh Section of the A.C.S. appealed for volunteer members to canvass the high schools of the vicinity to alert principals and guidance directors, and, wherever permissible, to speak to the students themselves concerning the nation's drastic need for chemists. This year the appeal was repeated. Teachers are urged to search out those with special ability and interest and to encourage them by every means in their power, such as contests and scholarship examinations, to respond to the nation's need for trained chemists.

Pittsburgh is second to no other city in the country in its stimulation of scientific research for youth. The annual Buhl Science Fair has brought out much talent in the past and has been an invaluable aid to teachers in their endeavor to stimulate students. It is hoped that this project will start many students on a scientific career. The annual High School Chemistry Contest sponsored by the Local Section of the American Chemical Society has contributed enormously to the stimulation of student interest.

What of that large group—the non-chemists?

Only a very small per cent of those studying high school chemistry, however, intend to be chemists. The very large majority will be housewives, business men, politicians, public servants, lawyers, writers, teachers, salesmen, and the like. They will never formally study chemistry after their high school course. What should the high school course do for these? What should we teach in a chemistry class to justify its place in the curriculum to those who will never be chemists, to those who don't even want to study chemistry? The course must be such as to convince all concerned that they just can't escape chemistry. This group is not much concerned with a groundwork in fundamentals. The course should give the student the background to face problems. It should give some general, over-all information to the engineer, the housewife, the average citizen, to help them to live more intelligently. It should give the future business man, for example, enough information to know when to consult the chemist and how to interpret the answer.

What are the current trends in high school chemistry? Who are the authorities who decide the trends? How do they accomplish their purpose? Modern trends can best be determined by consulting practical teachers. The authorities we have chosen are those high school teachers who have produced tangible results locally as sponsors of winners in the A.C.S. High School Chemistry Contest and the Buhl Science Fair, and nationally as publishers of articles on the teaching of chemistry. In our discussions with the former group each was asked for his personal convictions on the teaching of high school chemistry and his explanation for his success. The following analysis represents the opinions of twenty teachers, eleven of whom teach in schools in this vicinity; the other nine teach in high schools or colleges throughout the country and have published their opinions in such teaching aids as the *Journal of Chemical Education* and the *Science Counselor*.

Eight of our twenty authorities believe that the number one modern trend in teaching chemistry is toward the education of the whole person for intelligent citizenship. They consider that the chemistry course has a definite contribution to make to the picture. Three [1, 2, 3] of these advocate the new trend proposed by President Conant of Harvard and supported by Dean French of Colgate and Professor Taylor of Princeton and described as the case history approach. They believe that science is not being assimilated into our culture to the extent that it should be. They advocate a new approach to secondary teaching and freshman college teaching to provide time and place for the logical development of scientific thinking. They feel that the science course, consisting of facts, principles, and problems necessary for professional training, allows no place for the logical development of scientific thought or for an explanation of the historical heritage so necessary for understanding the growth of science. They recommend a course of important historical scientific topics so that students may study how early problems arose, how they were attacked, and the significance of their solution to society. Such a course would include the difficulties involved with each new advance, the false steps, the mistaken conclusions, the human obstacles of pride and prejudice, the new experimental techniques, the relationship of experiment and theory,

the modification or displacement of one theory by another.

One of these three[3] in his attempt to make science a part of our culture, defines it as science, art, craft, recreation, religion, language, and humanity. He summarizes his article with the conclusion that,

> "Science is a truth learned by scientific means; the art of using science helpfully, the craft that employs scientific skill, recreation in which nature is a pleasant companion, religion for which some men will die, a language that expresses a way of thinking suited to each age, one of the humanities lifting the culture of the human race, a hope for the preservation of civilization."

This teacher links his hope in science with his trust in God since the laws of nature are the laws of God. To him, the purpose of science is to learn God's laws and apply them to our needs.

One teacher[4] advocates the historical approach using a technique which differs from the case history approach. He has a historical book shelf showing 200 years of science growth. By studying books from this shelf the students discover for example that there were no symbols or formulas until 1830; that symbols and formulas were mostly incorrect until 1870; that the work of Berzelius was largely responsible for modern symbols; that the role of Avagadro's principle, enunciated in 1811, was not understood until 1858, which recognition made correct formulas impossible (except by chance) until 1860. The discovery of the student that from 1850 to 1870 the formula for water in chemistry textbooks was HO, and that for hydrogen peroxide, HO_2, drives home to him the importance of Avagadro's principle more than pages of explanation could possibly do.

Another three[5, 6, 7] of these eight consider the intangible contributions which the study of chemistry can make to the development of the character of the student of vastly greater importance than the factual or theoretical knowledge of chemistry itself. They aim to train the students to be people of decision. The laboratory is their workshop. They do not use standard laboratory manuals. The students plan their own procedures and write up their own reports. One[6] of these teachers thinks that the chemistry laboratory course proposes the ideal situation for training in honesty. "Dishonesty can be partly a habit. In our zeal for accuracy we should be careful not to encourage its formation. High school chemistry does not aim to train analytical chemists." This teacher believes that quantitative experiments should have as their purpose the development of certain techniques and mathematical relationships rather than the obtaining of better and more accurate data. Emphasis should be placed on interpretation of results, not on results themselves. Undue emphasis on accuracy itself will pressure the weakling into errors far worse than inaccurate results. A good interpretation of error is of far more value to the student than a good result obtained by luck or some false method. These teachers insist that somewhere, somehow, the course in chemistry should rise above equations, formulas, and problems and give the students a sense of the orderliness of the universe, the beauty of its dependability, and our unique place in the scheme of things.

One[7] of these three considers that a knowledge of science contributes to anything and everything. Laboratory technique develops the habit of anticipation. This teacher considers forethought to be a habit which comes only with training. In the same way he considers efficiency to be a developed talent and one which secondary education should stress as a basic technique of successful accomplishment. This teacher considers that the three skills of analysis, coordination, and positive accomplishment should be the objectives of all science courses no matter what the subject and who the student.

One of these[8] eight uses the laboratory to make science concretely more meaningful to the student as a consumer and an enlightened citizen. He points out to the students that the average American believes in science rather than understands it. He calls attention to the fact that advertisers are good enough psychologists to recognize and exploit the public's faith in science. Advertisements use such expressions as "Science discovers new easy way," "New evidence proves," "An achievement of science," "the great scientific discovery," or "these scientifically controlled tests." These expressions seem to lend validity to the claimed superiority of their products, which the scientifically untrained accept without challenge. This teacher guides his students in the development of tests to verify the validity of such claims. The students' activities include: critical reading of the advertisement, analysis of evidence presented, planning an experimental design to verify the claim, collecting and organizing data, drawing conclusions from results, and recognition of limitations. This procedure not only helps to produce a more enlightened citizen, but gives the student practice in the scientific method and serves as a stimulation and motivation for further investigation of that sort.

Of these twenty, four[9, 10, 11, 12] aim to produce scholars. Two of these four offer a second course, one in inorganic preparations, the other in qualitative analysis. Both classes are small groups of eight or ten students and students for both are hand-picked. Both teachers believe that earnest, intensive laboratory work is the only way to develop that coordination of hand and mind that every laboratory chemist must possess. The "feel" of apparatus comes only with experience. There is no better way than intensive laboratory work to develop observation and resourcefulness. One[11] stresses that the teacher must have a very broad training in all the sciences since the artificial boundaries of several sciences are crossed freely. One[10] makes no formal assignments and uses no one standard textbook. His library is well equipped and the students are expected to use it constantly. Of the 300 students he has taught, 33 per cent have earned either the M.D. or Ph.D. degree. He has fifty Ph.D. students to his credit, with ten in the making. He has sponsored three first prize winners and two third prize winners in seven years in the A.C.S. High School Chemistry Contest. This teacher believes that there is a direct relationship between the student's general knowledge and his chemical knowledge. He administers a general knowledge test consisting of sixty to seventy questions at the beginning of

the term and finds that 90 per cent of those who do well in chemistry do well in the general test.

The fourth[12] teacher of this group conducts two classes, one general and one advanced. The advanced class has had no previous chemistry, but is chosen on the basis of I.Q., past grades, interest, and an interview with the teacher. This group delves much more deeply into such chemical knowledge as molar solutions, electrodeposition, acid-base titration, redox reactions, etc. The students use a college text from Christmas until the end of the course. This teacher sponsored second and third prize winners in the A.C.S. High School Chemistry Contest last year. He has had winners in the Buhl Science Fair in the past.

Nine teachers of the twenty try to take care of both the prospective chemist and the non-chemist. Of these nine, one[12] has two classes—one advanced and one general. Three[5, 12, 13] plan to have a course for those "nice" people with a good attitude who just can't keep up with the work of the class. They would adjust their teaching to the students' ability and present, not a systematic, but an applied chemistry course. In this course they would steer away from the more abstract concepts and organize around very familiar substances.

Two[13, 14] of these nine value formal teaching less than student activities. One[14] prefers to omit teaching even such fundamental topics as hydrogen or oxygen in order that the student may have time to work on a project of his choice. The other[13] teacher has her students select a topic and develop an investigative theme. Both of these devices have produced two prize winners in the Buhl Science Fair.

One of these nine[15] feels that the atom, atomic energy, atomic structure, etc., should be *the* trend in high school chemistry. He centers his whole course around the atom. Another[18] thinks that some day everything may center around the atom but when that time comes its study will be transferred to the physics course. One teacher[5] thinks the atom is "the rage for awhile" but in four or five years we may have to change our ideas about it. He prefers to work towards it slowly until more definite knowledge is obtained.

All of these nine teach with the average student in mind and try to stimulate interest in outside activity on the part of those students of superior ability or interest. These are urged to undertake projects in Buhl Science Fair or the A.C.S. High School Chemistry Contest. The teacher's activity consists of guidance and inspiration outside of class. One[14] of these teachers considers that spectacular success in terms of prize winners depends almost entirely on the calibre of the student. He pushes no one, but is ready with help when called on by anyone. Three[10, 17, 19] others feel as strongly that there is no substitute for the enthusiasm and inspiration of the teacher. Their conviction is that an enthusiastic teacher will be an inspiration to all types of students—chemists or non-chemists. Two believe[18, 19] that no matter what the goal, the topics chosen should be taught thoroughly rather than that much should be presented with little mastery.

Only one[20] of the local teachers considers the semimicro laboratory method as a modern trend. Her experience is that the student is more alert to see results since they are less obvious than on the large scale; that this alertness develops a finer technique and is a better preparation for college chemistry. One[18] other teacher thinks the semimicro will come into high school chemistry after it has become well established in the college courses.

Two teachers[21, 22] in Hartford schools, one public and one Catholic, are using the semimicro approach and find it very desirable. One teacher[21] uses it as a lift to the course and believes that besides being faster and more economical, it demands greater skill of manipulation and observation.

The Archdiocese of Detroit uses the method in all of its new installations. The Superintendent[23] states that pupil knowledge of chemistry is equal to that of those using the macro-method; that the method is far more economical, which enables more schools to teach chemistry, and more pupils to enjoy its benefits; and that the laboratory can be used for other classes, thus saving the initial capital cost of class rooms.

In conclusion, what do these teachers have that others do not have? All of necessity must pursue at least one of the three methods of approach in teaching: to produce scholars, to train good citizens, or both. Yet these teachers have had tangible results which show their success. As far as results are concerned, it doesn't seem to matter which goal the teacher has in mind since all three have resulted in success. There must be something that these teachers possess in common. This investigation points to three common characteristics: knowledge of their subject, enthusiasm, and drive. No emphasis on special subject matter is necessary; no one point of view takes precedence. The teacher whose personality includes to an eminent degree knowledge of his subject, enthusiasm and drive will be the successful teacher. A review of trends is primarily a review of teachers and methods, not subject matter. Subject matter changes only with new knowledge, and teaching new knowledge is not a trend but merely keeping up to date. ●

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(Continued on Page 154)

Slants on Conservation Education

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This is an eloquent statement of our need to become aware of, and to halt, the wasteful exploitation of our natural resources that goes on all about us. Conservation becomes especially important today when at the expense of our own dwindling resources we try to feed and rehabilitate so many destitute nations.

Everyone may teach conservation, first by understanding what it means, and then by talking about it, by taking an interest in conservation legislation, by participating in youth activities, and by being better neighbors and citizens.

Teachers have an excellent opportunity to influence the thinking of others on this important subject.

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It is doubtful if primitive men ever gave a conscious thought to the possibility that there might some day be a scarcity of those animals which furnished them with food and clothing. Indeed, they were so outnumbered by all manner of wild beasts as to make a positive declaration on that point sound ridiculous. They were not even hunters in the true sense of the word, since most of the time they themselves were hunted. But, they had to eat; so when the opportunity presented itself they somehow managed to bring down one of the less dangerous beasts, usually a grass eater.

After men learned to live together and began pooling their forces against the truly formidable carnivores which were contemporary with the earliest men, they emerged from their caves and took up a nomadic manner of living. Without their being aware of it they had taken the first step toward the practice of conservation. Obviously, they seldom remained in one place long enough to completely deplete its animal life.

The nomadic tendencies of the American Indian had a salubrious effect on wildlife, although the impression that the Indian killed no more than he needed is far from the truth. The Indian was an opportunist. When favored by good fortune he fared sumptuously; in hard times he all but starved.

For more than a million and a half years men had a background of the hunter. He had to hunt in order to live. To accomplish his purpose he had to kill. In fact, the most highly respected members of the tribe, clan or community were the most efficient and consistent killers. Skillful hunters were the best providers, so we find that most women favored them. It was nature's way to make certain that the family survived. Since a contented family life is considered the very core of civilization and progress, you can readily understand the importance of the family breadwinner.

Man comes honestly by his killing proclivities. To repeat, he had to kill in order to eat. With countless generations of his forebears doing exactly that, is it any wonder that man comes into the world imbued with this primordial instinct? In their formative years, say, between the ages of four and nine, many male children are cruel to an extreme unless wise parents curb the instinct at an early age, or, better still, direct it into the proper channels. Naturally, it is frequently difficult to differentiate between cruelty and abject irresponsibility. Anyway, the instinct, a remnant of an atavistic past, often persists until a child acquires the inhibitions imposed upon him by a civilized society.

Questioning thousands of school children and Boy Scouts over a period of more than a quarter of a century, reveals that it is rare indeed, to find one who doesn't admit killing birds and small mammals for no reason at all or because he found it to be fun.

When the instinct is sublimated and modified and directed into the proper channels, it really motivates the accomplishment of much good in the teaching of the wise use of our natural resources.

Two of the most active civic leaders and ardent champions of conservation that we know of were at one time apprehended with the legs of thirty-nine songbirds which they had shot in the

VAST PLAINS lush with rich grass and rimmed by the inevitable mountains is only one of the great array of riches with which our country is blessed. This is near Choteau, Montana.

course of one afternoon. Like so many scalps, the legs of their victims dangled from belts to which they had been fastened. Untutored by their parents, they promptly answered the call of the wild just as any red-blooded boy would have done. Paradoxically, it was their love for the out-of-doors that prompted them to commit what to others was a dastardly deed. No number of laws would have stopped those boys from doing what they did. Later, they were asked if they at any time suffered any remorse. "Only when we got caught," they admitted.

For years we have punished violators and in a small way stemmed the flood of deliberate infractions as well as those committed through sheer ignorance. The problem as we see it is not one of correction, but of education. And the educative process should reach every one, adults and children of both sexes.

Nothing seems more futile than trying to explain the intricacies of conservation to a group that does not have a knowledge of the barest fundamentals. Unless every individual in an audience is made aware of his or her importance in the conservation picture, then, the objective which we seek is still in the distant future.

We have heard experts go into long and vivid descriptions of the dire consequences if the precepts of good conservation practices are not adhered to. In one case an internationally famous authority harangued to a stunned audience about the terrible after-effects on a ravaged planet. For some minutes after he had finished, my reactions were like those of the rest of the assemblage, a complete and utter helplessness in the face of unsurmountable odds.

However, the speaker's efforts bore some fruit; his talk reached a few thoughtful individuals who decided to do something about it. They promptly put their shoulders to the wheel to help spread the gospel of conservation. How? By talking about it at every opportunity; by increasing their interest in legislative measures designed to further the cause within their county and state; by actively participating in youth activities; by being better neighbors and citizens.

Yet, the picture presented by that distinguished speaker was well nigh unbelievable in the face of the smug and comfortable circumstances of most of the listeners. There they were ensconced in comfortable and even luxurious homes, many owned one or more cars, while all of them were assured of three square meals a day despite the high food prices. Yet, this man spoke of exhausted soil, foul water, no water, starvation, thirst and even death. To be sure, it was death in a distant land, but death nevertheless. Some resolved on the spot to increase their contributions for foreign relief while others, after recovering from the initial shock, just shoved it aside as something that did not concern them. How could it? As one apparently intelligent woman put it, "And I thought all the while that conservation was something that had to do with trees."

An impressive speaker with an important and timely message doubtlessly reaches most of his listeners, but all too often the message does not stick because it is projected in a speech. Speakers before service clubs are especially handicapped because the meetings feature weekly speakers. The glut of speakers tends to blunt the listeners' receptiveness even to those who may have a vital and timely message. Again, however, no opportunity should be lost by the adherents of conservation to help further their objectives. Even if only one individual in an audience is reached, the effort may be considered worth while. Persons so reached often become the most zealous proponents for the cause in their respective communities.

Since the instinct to hunt and fish is so deeply ingrained in man, he has of necessity exercised it; at first to furnish him with those things necessary to maintain life, and then as an expression prompted by an impulse difficult to thrust aside. Modern sport hunting is simply a manifestation of man's virile past. It not only proves his mastery over the lesser creatures, but also reveals him as their most devoted champion. What is more, it keeps him in touch with the elemental things so necessary for a normal life.

Man's capacity for outdoor pursuits has resulted in the development of many related interests. It is doubtful if primitive man ever admired or even saw the beauty of an animal or a tree or even a colorful flower; the sense of the esthetic developed long after his love of the chase was well entrenched. These so-called intangibles which a modern sportsman prizes so highly were recognized as such only after a long evolutionary process.

Now, we cherish the symmetry of a tree, the cool recesses of the noonday forest, the tumbling waters of a mountain stream—yes, even the sagacity of our quarry. Because of their keen perception and appreciation developed by understanding, sportsmen have come to value these adjuncts in many cases more highly than the mere bagging of game.

Those of us who are more elemental still insist that the epitome of the chase is the bringing home of the bacon. Here we are but satisfying another primitive emotion, that of approval by our fellows in being able to outwit our game. Who doesn't admire an expert woodsman or a good shot?

Since the outdoorsman realizes more than anyone else that the wasteful exploitation of our natural resources spells doom to his sport, is it any wonder that he tries to spread the doctrine of wise use? To those who are not conversant with the charm of the outdoors this seems paradoxical. But, if you have trod the pine and moss carpet of a coniferous forest or slaked your thirst at a crystal spring amidst a bower of dank ferns, or you have seen the sun rise from the early morning mists as you watched from the vantage point of a mountain top, then, in a measure, you will understand what to the average individual seems so absurd. The pity of it all is that there are so few so close to these elemental things.

As we indicated earlier in this piece, the open sesame to the solution of the conservation problem is education; education from the ground up. All that has been accomplished to date is to acquaint the key figures with

(Continued on Page 150)

The Story of Hypodermic Syringes

• By Public Relations Department
BECTON, DICKINSON AND COMPANY, RUTHERFORD, NEW JERSEY

Few modern physicians can practice without a hypodermic syringe. One of the most used medical instruments, the hypodermic syringe has an interesting history.

This article traces the development of the syringe and needle, and describes the latest developments in the field.

●

The history of the hypodermic syringe may be traced back to the beginning of the last century when pioneer attempts were made to inject medicaments into human tissue by means of a hollow needle and syringe. Even earlier, in 1657, Sir Christopher Wren, by using a slender quill attached to a bladder, first injected drugs into a living human being.

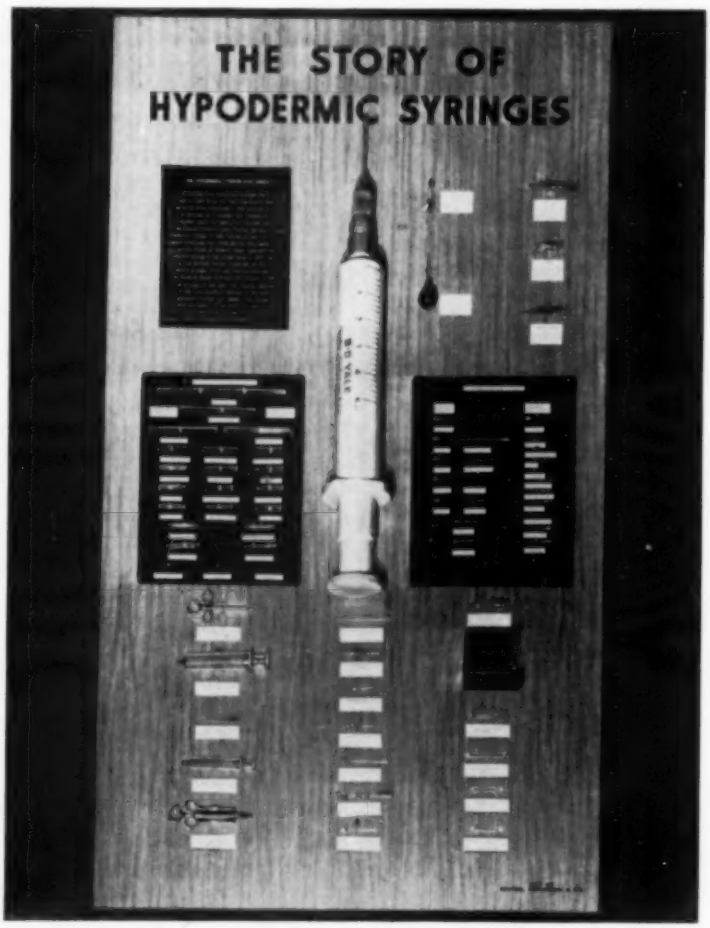
Before 1836, when Dr. Lafargue of France invented a needle trocar for depositing morphine in paste form, drugs had been rubbed into a previously made incision.

A very fine precision instrument today, the development of our present hypodermic instrumentarium stems from two New York doctors, Taylor and Washington, who in 1839 were the first to use an Anel syringe for the administration of a solution of morphine. Theirs was a small syringe of sterling silver with a leather piston. It had a fine, elongated, tapering nozzle inserted under the skin after an incision had been made.

The first actually to make a needle entirely separate from the metal syringe was Dr. Charles-Gabriel Pravaz of Lyons, France, in 1853. Even today, hypodermic needles and syringes used in European countries are commonly known by his name.

In the United States, the first patent on a hypodermic syringe was granted in 1873 to Ephriam Cutter, although syringes had been made by George Tiemann & Co., New York, since 1856 when Dr. Fordyce Baker of New York introduced the Ferguson syringe of Scotland to this country. Other early American syringe manufacturers included William Autenrieth of Cincinnati, Gemrig & Son and Charles Lentz & Sons, both of Philadelphia. Their products were made of glass, hard rubber, sterling silver, celluloid and German silver. The pistons mostly were of leather.

The first all-metal syringe with "ground-in" piston apparently was the Detmers-Robinson, made by Codman & Shurteleff of Boston in 1894. Many types of syringes followed, including those with a glass barrel and rubber or asbestos pistons. The Record syringe, which consisted of a metal plunger and a glass barrel, was invented in 1906 by Dewitt and Herz in Berlin.



THIS PERMANENT EXHIBIT by Becton, Dickinson and Company is in the Smithsonian Institution, Washington, D. C. It graphically pictures the evolution of hypodermic syringes and needles.

Easily the most radical change in syringe-making came in 1896 when Karl Schneider, an instrument maker for H. Wulfing Luer of Paris, invented the Luer all-glass syringe. The American patent on this syringe was acquired by Becton, Dickinson and Company of Rutherford, New Jersey. They were the first to market it in this country—on October 8, 1897.

Since that time, Luer syringes, which now have practically displaced the all-metal, leather-packed and asbestos-packed syringes and

(Continued on Page 148)

Current Scientific Writing

• **By Lois Kennedy**
UNDERGRADUATE STUDENT, MARYCREST COLLEGE, DAVENPORT, IOWA

An interested undergraduate examines the science content of articles published in two non-scientific magazines during one-year periods that were separated by a five-year interval.

At present, biology, medicine and public health seem to hold the greatest reader interest.

●

As modern progressive people, we know that the time in which we are living is one of advancement, of development, particularly in the natural sciences. In the development of electronics, nuclear physics, medicine, and public health lie many factors which will affect us as a nation and as individuals. Therefore, we expect a good percentage of current literature to be about science.

It is important for us to follow events in the world of science and to be concerned with the significant economic and humanistic aspects of the physical sciences. For, as Mr. Edward Weyer, Jr., editor of *Natural History* says:

> Dictators and governments itching for authority naturally seek control over science. Science is the search for new tools, new weapons, new ways of life. It is the total of man's efforts to push back the frontiers of ignorance and make a better physical world. Control of science means a subtle control over a large part of life.

Therefore, since science is important to us, it becomes worthwhile to investigate the sources of our scientific information, coming largely from periodicals. The purpose of this paper is, through a survey of science articles in two current magazines and a survey of science writing in general, to evaluate the scientific information which we as thinking, educated people are receiving. In evaluating current science writing I have kept in mind the question, "Are people receiving today enough information which is accurate, readable, and interesting?"

At the beginning of this survey I decided to evaluate the science articles in each issue of a magazine for two two-year periods, five years apart. By using a two-year period I was able to survey enough articles on which to base generalizations; by allowing a five-year interval I was able to contrast the articles of the earlier date with those of the later date.

I also decided to use either one type of magazine, or a cross-section of the "popular," "middle-class," and "intellectual" types. *Harper's Magazine* and the *Atlantic Monthly* seemed particularly well suited to my purpose. The science articles are from the years 1946 and 1947, 1952 and 1953. Since these magazines carry articles of general interest—public affairs, the arts, literature, science, sociology, and economics — it is safe to assume that people read them not only for one certain field which they cover, but so that they may become better acquainted with current topics.

One would not, of course, in a non-technical magazine expect to find many articles presenting scientific information without applying it in some way to other fields. I realized that most of the articles are only in part about science, or else that they present the scientific facts and then apply them to economics and public affairs. An example of the first type of article is found in the September, 1952 issue of the *Atlantic Monthly;* it is concerned with the medical, religious, and political factors—influencing the problems of birth control in India. In this case, as in many others, the scientific aspect of the problem is only one of several aspects. However, I classified such articles as scientific because of the importance of this field in the problem.

In contrast with the first type of article is the more technical study. One such essay, published in the April, 1952, issue of *Harper's Magazine,* concerned experiments with nucleoprotein, a constituent of living matter.

I also restricted my classification of articles to those which treated subjects in such natural sciences as physics, chemistry and biology. Studies dealing with earth science, biography, and philosophy, as related to the natural sciences, were likewise included. This restriction excludes psychology, so often included with the other sciences.

As a basis for the restriction of the type of article used, I quote Philippe Le Corbeiller, a mathematician and philosopher. He says in the *Atlantic Monthly:*

> We may call "science in the stricter sense" any coordinated group of quantitative laws, and "science in the broader sense" any body of knowledge obtained according to ethical rules. We may say that physics, chemistry, and a small part of biology are sciences in the stricter sense.

The next step in the survey involved classification of the articles according to the fields of science to which they belonged. In spite of the fact that a poll conducted in 1950 showed that editors had a special preference for science and public health articles, it is interesting to note how varied the publications are from the standpoint of subject matter. The following tabulation shows the number of science articles in each field for each two-year period.

SCIENCE ARTICLES

Subject	1946-1947	1952-1953
Biology	5	11
(Anthropology)	2	5
(Zoology, Botany)	3	6
Medicine and Public Health	4	10
Physics	6	7
Chemistry	2	4
Earth Science	—	4
Philosophy	6	2
Biography	—	2

The total number of science articles in 1946-1947 was twenty-three; in 1952-1953, forty.

There is only one more article relating to medicine and public health than to physics. But the number of articles on medicine in 1952-1953 is double that for 1946-1947, whereas the number for physics is about the same. One can conclude from this that whereas physics (particularly nuclear physics and aeronautics) was in vogue just after the war, people are now beginning to interest themselves in a field closer to their personal concerns—modern medicine. The increase in articles published in such related fields as anthropology, chemistry (biochemistry), and zoology, and the reduced number of publications in philosophy and ethics (articles primarily concerned with the morality and control of atomic warfare) help to support this conclusion.

There was almost one hundred per cent increase in the number of scientific articles from the 1946-1947 period to the 1952-1953 period. The proportion of science articles increased from about one in twenty-seven to one in sixteen during this time. At the same time the number of pages and the size of the two magazines remained about the same, showing a proportional increase over other articles. From this information, and from the tabulation above, we may conclude that science has grown in public importance, and that people are becoming more interested in scientific literature and in the application of science to themselves.

However, if we look at our problem from another point of view, it will appear that we are not receiving as much science information as we should. By the tabulation below, we can see that of the total of sixty-three science articles, forty-six are between four and seven pages long.

LENGTH OF SCIENCE ARTICLES

Pages	No. of Articles
1	1
2	1
3	4
4	11
5	11
6	14
7	10
8	5
9	3
10	1
11	1
12	1

The average, then, is almost six pages, which is about right for the general non-technical type of article surveyed. Since an annual average of sixty pages out of a total of twelve hundred pages per magazine is devoted to science, the amount of science information in one magazine seems relatively low. But the amount of this information has doubled since the 1946-1947 period, and will probably continue to increase as science becomes more important.

The sharp rise in the number of science book reviews in *Harper's Magazine* even more definitely shows the increase of popular interest in this field. There were only four of these reviews in the earlier period, while there were ten in 1952-1953. According to the type of books reviewed, the interest of readers in the biological sciences predominates over other fields.

BOOK REVIEWS

Subject	No. of Books
Biology	14
Anthropology	4
Medicine	6
Geology	1
Physics	6
Biography and History	4
General	2

From the tabulation above, we can see that twenty-four books out of a total of thirty-seven deal with phases of biology, anthropology, and medicine.

Now that we have looked over the science articles of *Harper's Magazine* and *Atlantic Monthly* from a statistical point of view, it might be worth while to evaluate them as representative of the whole field of current popular science writing. In evaluating the contributions we shall consider if they are fulfilling the purpose of good scientific journalism, namely, to present scientific information clearly and concisely and to stimulate an interest in current developments in this field.

In such an evaluation, it is obviously important to know who writes about science. According to the survey there are two types of writers, the professional science writer and journalist and the scientist himself. The former group has a slight majority.

First, we shall consider the professional science writer. In some respects he is better qualified to do the writing; he has a good background knowledge of all science fields, and is well trained in the skills and techniques of writing. On the other hand, the scientist with a thorough knowledge of one field and a general knowledge of others, may find it difficult to write in a stimulating manner. However, the professional writer, in his attempt to make an article entertaining and persuasive, not the primary purpose of scientific writing, may carelessly construct an hypothesis from a conjecture. As Kirtley F. Mather says in an article on science reading in *Science*, "The necessity for careful distinction between speculative ideas and firmly supported concepts imposes a responsibility upon all authors of scientific literature, but it should also keep all readers alert."

The science writer is often criticized for striving for an overly-light effect reducing the importance and meaning of an article. He may use slang and meaningless journalistic cliches in an attempt to make the article more interesting and readable. In an article on scientific writing published in *Science*, W. W. Pirie explains that a journalist assumes that only about a third of what he has written will be read; and therefore the number of ideas presented is fewer than in a paper of the same length written by a scientist.

(Continued on Page 152)

NEW BOOKS

The Lippincott High School Science Series

- Chicago: The J. B. Lippincott Company. 1954.

Science for Everyday Use

- *By* VICTOR C. SMITH and B. B. VANCE. Pp. XIII + 737. Third edition.

Biology for You

- *By* B. B. VANCE and D. F. MILLER. Pp. 652. Third edition.

Physics for the New Age

- *By* ROBERT H. CARLETON, HARRY H. WILLIAMS and MAHLON H. BUELL. Pp. XVI + 656. Revised edition.

Chemistry for the New Age

- *By* ROBERT H. CARLETON, FLOYD F. CARPENTER, and R. W. WOLINE. Pp. IV + 688. Revised edition.

A school system would do well to adopt any one of these new Lippincott high school science textbooks. It would do better to adopt all four. Pupils and teachers alike will enjoy them, for successful and experienced teachers, mostly in the secondary field, wrote them. The series as a whole has been unified through the editorial assistance of Dr. W. R. Teeters, director of education in the St. Louis public schools. That their teachability has been thoroughly tested is shown by the fact that the chemistry and physics texts are revisions made after five or more years of classroom use, and the general science and biology texts are third editions.

The scientific competence of the writers guarantees the authenticity and recency of the information they present. And although, as is to be expected, an occasional cloudy statement is to be found, the authors' ability to write simply and interestingly is apparent on every page. Care has been used in the selection of the non-scientific vocabulary. Definitions are clearly stated. Teacher and student aids are plentiful. Throughout, the interrelationship of sciences has been emphasized. Many of the exercises are designed to help the pupil discover such relationships and to apply his knowledge to new situations. Laboratory manuals are available for use with each text.

The kind and amount of material to include in a high school text is a matter of personal judgment. A chemistry text of 688 pages, for example, might seem to be too extensive for coverage by the average high school class in one year. When the text is examined, however, it is found that of the first two Units, which occupy 140 pages, 39 pages are devoted to teaching and learning aids, high lights, reviews, tests, application exercises, problems and problem solving, and "things to read." In addition, in the same section of the book there are seven tables, 15 diagrams and drawings, 30 half-tone illustrations and one color plate.

The publishers have done an excellent job in selecting type faces, paper, and bindings. *H. C. M.*

Rotating Electrical Machinery

- *By* CROW-ELECTRI-CRAFT CORPORATION. Vincennes, Indiana: Universal Scientific Company, Inc. 1954. Pp. 256. $3.50.

This book, which presents a simple but entirely practical approach to the study of AC and DC machinery, is based on a manual that has been used successfully in the Navy's program for the training of electrical and electronic technicians. It is designed for use with the attractive Crow Electri-Kit Model 700 that is now filling a very real need in many high schools. Here is splendid help for the teacher who may not feel completely at home in the teaching of electricity.

Step by step the pupil is taught how to build and operate assemblies that will function like commercial machines. Directions are simple and complete. Only elementary mathematics is involved. The 300 sketches and diagrams are outstanding in their clarity. They do much of the teaching. Some 25 operating machines are discussed. Attention is given in each case to the theory involved.

Every high school teacher of physics and every scientifically inclined boy in his class will want to own and use this book. So will many electrical technicians and repair men. *H. C. M.*

Irrigated Soils

- *By* D. W. THORNE, PH.D., and H. B. PETERSON, PH.D. Second Edition. New York: The Blakiston Company, Inc. 1954. Pp. XII + 392. $6.50.

Today, the United States has more acres of irrigated land (21,170) than any other country except China (90,000), India (40,000), and Pakistan (35,000). Yet most Americans know comparatively little about the how and why of this ancient agricultural practice. This book offers much useful information about the problems involved in planning and operating an irrigation system. Land evaluation for irrigation, soil-water-plant relations, the salt problem, the source, quality and measurement of water, drainage, controlling the physical and biological properties of soil, the selective use of fertilizers, farm planning, and many other pertinent topics are considered. The main emphasis is always on fundamental principles, then on the application of the principles in solving the problems encountered in practice. Here is a wealth of information for the specialist,

the agriculturist and the lay reader whether they are interested in the irrigation of an arid region or as a supplement to natural rainfall in more humid areas. An important book in its field. *H. C. M.*

Comparative Anatomy of the Vertebrates

• *By* GEORGE C. KENT, JR. The Blakiston Co., N. Y.: 1954. Pp. XII + 530. $6.00.

The author presents comparative anatomy from an anatomical rather than a taxonomic viewpoint. Four chapters of the book are devoted to general introductory material consisting of vertebrate characteristics, relationship of vertebrates to closely allied subphyla, phylogeny and ontogeny, and embryology. The remainder of the book is divided into individual chapters according to the anatomical system discussed. Similarities and differences among the various vertebrates are presented. Many excellent illustrations are interspersed throughout the text. To each chapter is appended a summary which the reader will find useful in highlighting information from the various chapters which of necessity are overburdened with anatomical nomenclature. Until such time as anatomy texts are written with physiological content to provide a more dynamic concept of biology, the only improvement in such books will be in the organization of subject material. The author of this text has succeeded in this attempt.

John G. Adams, Ph.D.
Department of Pharmacology
Duquesne University

Modern Science and God

• *By* P. J. MCLAUGHLIN, D.ÉS SC. New York: Philosophical Library. 1954. Pp. 89. $2.75.

This little volume contains the English translation of the well-known address delivered by Pope Pius XII to the members of the Pontifical Academy of Science on November 22, 1951, which is concerned with the contributions made by modern science to the proofs for the existence of God and the creation of the world. The translator has added an introduction about the interest of the Pope in science and in the Pontifical Academy of Science. The text is accompanied by copious explanatory notes. Technical language has been avoided as much as possible. Anyone with a rudimentary knowledge of science and philosophy will be able to read this little work with profit.

Henry J. Koren, C.S.Sp.
Department of Philosophy
Duquesne University

School Science Facilities

• *By* JOHN S. RICHARDSON, Editor. Washington, D. C.: National Science Teachers Association. 1954. Pp. VIII + 266. $5.50.

Are you satisfied with your present teaching facilities in science? Probably not. If you are, perhaps you shouldn't be. In any case you can't afford to miss this newest, most authoritative, most complete, and most helpful publication on school science instruction facilities. It is "must" reading for science teachers and school administrators. It will be of immediate help where schools are being built or science rooms remodeled. Manufacturers of laboratory furniture and dealers in laboratory supplies and equipment will find it useful.

The book is based on a comprehensive study, begun in 1950 by the National Science Teachers Association in cooperation with the United States Office of Education, in which some 500 science teachers and eight national associations participated. Many ideas are included that can be incorporated into present science rooms with little or no expense. Attention is given to elementary science as well as to the multi-purpose science room in the high school, and to facilities for general science, biology, physics and chemistry. Classroom and laboratory facilities, utilities and service, equipment and supplies, storage, floor plans, and school and community resources are considered for each science. The check lists by which teachers may evaluate their own facilities offer to the alert teacher a multitude of suggestions for improvement. There are well planned lists of equipment and supplies suitable for each science. *H. C. M.*

Industrial Fermentations

• *Edited by* LELAND A. UNDERKOFLER, Ph.D., D.Sc., and RICHARD J. HICKEY, Ph.D. New York: Chemical Publishing Company. 1954. Pp. IX + 565. $12.00.

Certain commercially important fermentations have been known for a long time. Others are brand new. The field is developing rapidly. Once conducted empirically, the work has necessarily become scientific because of its increasing importance in industry, especially in the production of organic chemicals and medicinals. Specializing in certain limited areas has become necessary. The literature dealing with the field is limited. Consequently, this important book, with its various sections written by 19 active workers in the areas they describe, will be especially welcome. The information they give is authoritative and up to the minute. The many literature references offered will be most helpful.

The greater part of the book is devoted to alcoholic fermentation and its modifications, the fermentation of grain, molasses, waste sulfite liquors, and wood hydrolyzates. Considerable attention is given to commercial yeast manufacture and to food and feed yeasts. The butanol-acetone fermentation is described in detail. Special chapters, consider the fermentative production of lactic, citric, gluconic, acetic, and other acids.

Volume II will include consideration of the production of antibiotics, enzymes, vitamins, and other important materials. *H. C. M.*

Histopathologic Technic and Practical Histochemistry

• *By* R. D. LILLIE, A.B., M.D. New York: The Blakiston Company, Inc. 1954. Pp. IX + 501. $7.50.

This book, written by the Medical Director of the U. S. Public Health Service, is a rather comprehensive review of useful histochemical procedures. It is based upon the author's book *Histopathologic Technic* published in 1948. The first six chapters deal with microscopy and microscopic methods including equipment, fixation, sectioning, staining, and mounting. The remaining chapters consider special constituent and cell product histochemistry. Nucleic acids, amino acids, enzymes, endogenous and exogenous pigments, fats and lipoids, connective tissue fibers, bacteria, protozoa and other parasites, and many other topics receive attention. Optimal times and temperatures, pH levels, and reagent concentrations are specified for the various methods discussed. Procedures are described in sufficient detail that they can be followed by an experienced worker without personal instruction. Current literature sources are freely cited. The Foreword lists a number of histochemical works that will provide a beginning of a literature survey in this field.

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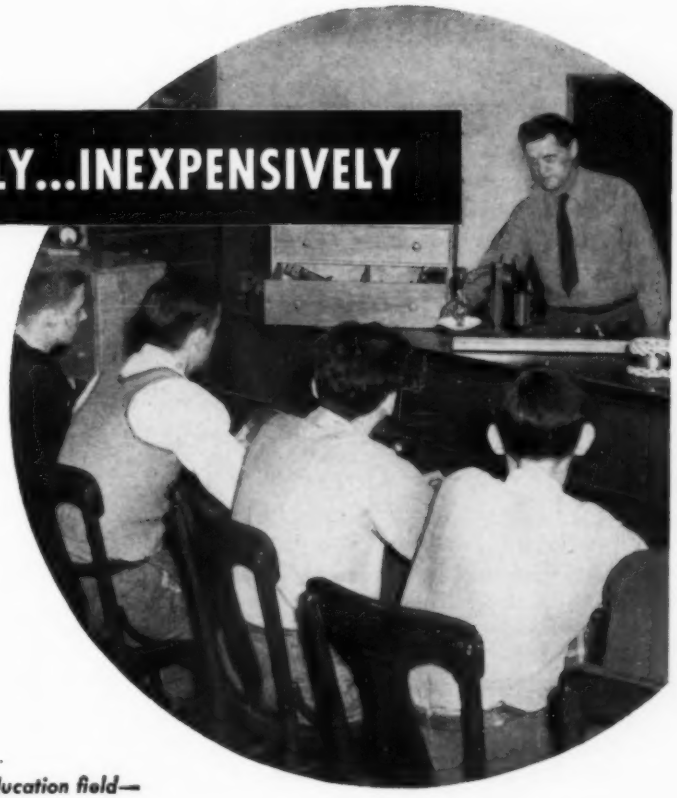

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Instruction About Alcohol

(Continued from Page 122)

Liable to Produce Addiction, a distinction is made in definition among addiction-forming drugs, addiction-producing drugs, and habit-forming drugs. The Committee recommended that the expression "addiction-forming" should be replaced by "addiction-producing." It defined a habit-forming drug as

> one which is or may be taken repeatedly without the production of all of the characteristics outlined in the definition of addiction and which is not generally considered to be detrimental to the individual and to society. The committee was of the opinion that the expression "habit-forming" in the sense of addiction-producing should be eliminated from all texts.[3]

In the Third Report, the Committee reiterated its opinion that the terms addiction-producing and habit-forming drugs are not interchangeable. They further distinguished:

a) drugs, morphine and pharmacologically morphine-like substances, whose action, under individual conditions of time and dose, will always produce compulsive cravings, dependence and addiction in any individual. With these drugs, pharmacalogical action is paramount, psychological make-up adjuvant. Such drugs must be rigidly controlled.

b) drugs which never produce compulsive craving yet their action is found desirable to some individuals to a degree that constitutes habituation. Psychological make-up is paramount, pharmacological action is adjuvant. They cause no sociological damage and do not need rigid control.

c) There are some drugs whose pharmacological action is intermediate in kind and degree between the two groups already delineated so that compulsive craving, dependence, and addiction can develop in those individuals whose psychological make-up leads them to seek and find an escape in drugs. With these substances psychological make-up is the determining factor but pharmacological action plays a significant role. In some instances individual and sociological damage develop, but since the incidence of the damage is not general, the type and degree of control of drugs of this group are better left at present to national consideration[4].

The Expert Committee on Alcohol of the World Health Organization in its First Report noted the various definitions formulated by the Expert Committee on Drugs Liable to Produce Addiction. In considering the pharmacological position of alcohol the committee

> recognized the existing state of confusion arising out of the indiscriminate use of the term "tolerance." It was felt necessary to make a distinction between the use of the term tolerance in connection with addiction-producing drugs of the morphine type, and that required for consideration of the problems which arise in connection with the use of alcoholic beverages.
>
> In the case of alcohol, which, in the form of alcoholic beverages, is consumed by many people as a social custom, a concept of tolerance is needed which describes differences in the inherent susceptibility of individuals to the effect of the substance on the function of the nervous system. It was therefore agreed to regard tolerance to alcohol as the capacity of the organism to function with alcohol in the blood without measurable deterioration in nervous function.[4]

The Committee further recognized the existence of some evidence to support the possibility of an acquired increase in tolerance to alcohol among habitual heavy drinkers. It noted, however, that

> Prolonged heavy intake of alcohol does not decrease the rate of absorption nor does it increase the rate of oxidation or excretion of alcohol. There is no evidence to show that the permeability of the haemato-encephalic barrier to alcohol is lowered.

It recommended further research to identify the determining factors, pointing out the necessity for adoption of a standard set of tests to permit comparison of results among different workers.

The following statement was agreed upon by the Committee in defining an appropriate category for alcohol:

> Alcohol must be considered a drug whose pharmacological action is intermediate in kind and degree between addiction-producing and habit-forming drugs, so that compulsive craving and dependence can develop in those individuals whose make-up leads them to seek and find an escape in alcohol. With this substance the personal make-up is the determining factor but the pharmacological action plays a significant role. Damage to the individual may develop, but does so in only a minority of users. The social damage that arises extends, however, beyond these individuals themselves.[5]

The technical difficulties involved in classifying alcohol as a drug are not insignificant even for experts. Further research carefully controlled with human subjects is indicated. It is obvious, however, that a positive correlation between the effects of alcohol and those of the opiates under all conditions cannot be substantiated by existing evidence.

The risk for young people in experimenting with alcohol lies less in the remote chance of physiological damage and addiction than in the immediate possibility of intoxication. Science teachers and writers might more constructively stress this aspect of alcohol use than the extremely technical implications of pharmacology, some elements of which still require documentation. ●

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★ ★ ★ ★ ★

"Members of the professions are to a great extent responsible for the drastic changes in the human environment and hence must be concerned for the competence of professional people to foresee and deal with the social and economic consequences of their work. As history shows, the solution of such social problems cannot be left wholly to nonprofessional people; it challenges the best that all of us can do, and members of the professions must do their part."

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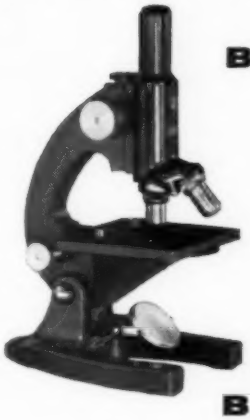

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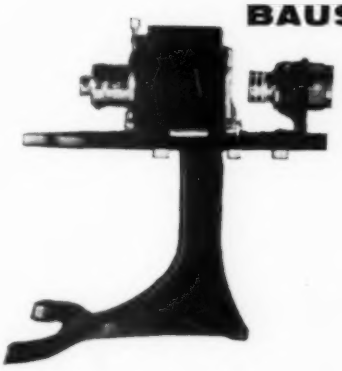

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Importance of Magnesium

(Continued from Page 126)

3. Those with a low ratio of magnesium to calcium			
Cheese	.037	.930	.03
Milk	.012	.118	.1
Eggs	.01	.06	.16
Orange	.01	.024	.3
Cabbage	.012	.046	.25
Carrots	.02	.045	.4
Kale	.03	.18	.16
Turnip greens	.028	.347	.08
Knoxville water	5.6	43.5 (p.p.m.)	.12

Percentage Composition of Human Tissues

Tissue	Magnesium	Calcium	Mg./Ca. ratio
Cartilage	.11	.04	2.7
Muscle (striated)	.02	.007	3
Muscle (cardiac)	.02	.009	2.2
Liver	.018	.008	2.2
Brain	.012	.01	1.2
Pancreas	.018	.015	1.2
Kidney	.02	.02	1
Muscle (non-striated)	.02	.03	0.7
Skin	.01	.014	0.7
Adrenals	.01	.016	.6
Blood	.004	.008	0.5
Thyroid	.01	.032	0.3
Bone	.2	20.00	0.01

and dysmenorrhea. Rawlings (1949) obtained relief of pain in dysmenorrhea by the use of 20 grains of magnesium gluconate once a day for 14 days prior to onset. A comprehensive investigation by Abarbanel (1945) demonstrated the usefulness of magnesium in childbirth and eclampsia. The magnesium gluconate was injected intravenously in 10 ml. doses of a 20 per cent solution.

Magnesium Therapy

Many drinking waters are hard and carry an abundance of calcium. High milk diets also supply excess calcium. Hyperactivity of the parathyroids or other glandular disturbances may alter calcium metabolism and perhaps other minerals. In hypothyroidism there is also a lessened excretion of calcium. In the pyknic type or mesomorph (chunkytype) there is a storage of calcium. In such cases, particularly where there is a tendency to constipation or arthritis or calcification with increase of the aging process, magnesium acting as an agent antagonistic to calcium will be of benefit.

Since diets are often low in available magnesium the deficiency may be made good by the use of four grams of magnesium citrate or gluconate which will furnish four-tenths of a gram of soluble magnesium.

Discussion

Bodansky is of the opinion that of all the waste products of metabolism, the most poisonous is acid. He further states that uremia is characterized by the poisonous accumulation of acid rather than urea or other nitrogeneous products. On the average diet 350 cc. .1 N acid is excreted.

This being the case, magnesium is not only important as a magnesium ion but also because of its divalent basic character that is capable of neutralizing acids, and thus aiding in maintaining the acid-base equilibrium.

According to Peschel and Peschel, "total base is more important than total acid from the physiological point of view." The composition of the rice diet used in kidney disease and hypertension by Dr. Walter Kempner helps to reduce the production of acid radicals such as phosphates and sulphates and favors the formation of bicarbonate reserve, and increased potassium.

It is now generally known that the liberal use of potassium fertilizers tends to cause deficiency of magnesium in plants, and even lowers the calcium and sodium content. Cattle fed on such high potassium forage develop grass tetany. Grass tetany can be relieved by injections of either calcium or magnesium.

The mineral constituents of cells are not only indispensable to life but must be present in physiologically balanced solutions, as follows:

$$\frac{Ca^{++} + Mg^{++} + H^{+}}{Na^{+} + K^{+} + OH^{-}}$$

An increase in any of the ions of the denominator tends to bring about the manifestations of tetany. We thus see that magnesium acts as a necessary mineral or electrolyte that helps to furnish a balanced environment for the semi-permeable membranes in ionic interchange. Such balance makes for proper functioning and good health. ●

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The Catherwood Diatometer

(Continued from Page 124)

abundant in the collections were also most abundant on the slides removed from the diatometer.

The Catherwood diatometer may also be used as a means for keeping a yearly record of the changes in the diatom flora of a river. Two slides can be removed every two weeks and stored dry for immediate study or for reference at a future date, since air-dried diatoms will retain their shape and characters for an indefinite period. Large numbers of slides removed from diatometers can be stored in a small space. The diatometer is also a valuable instrument to the limnologist for accurately locating stations for a complete biological survey of a river.

The development of the Catherwood diatometer as a relatively simple and accurate device for sampling the diatom flora of a stream will undoubtedly broaden the concept of population studies by the limnologist and ecologist in respect to the association of plant and animal populations of a stream in regard to water conditions. The use of the diatometer in population studies of diatoms is in its infancy with apparently unlimited opportunities for the future. ●

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★ ★ ★ ★ ★

Hypodermic Syringe

(Continued from Page 138)

regular Record syringes in the United States, have been vastly improved. One of these improvements is the addition of finger and thumb rests and rings to give the operator a firmer grip. This enables him to inject as well as aspirate with one hand. Stronger and better flanges have been developed to prevent the syringe from rolling and to permit a better hold. Dosage and other markings now are permanently fused into the glass. A clamp prevents the plunger from falling out. A black precision line at the end of the plunger facilitates quick measurement of dosage. Reinforced flanges, bottom and tip now hinder breakage. Better, smoother grinding gives a longer-lasting tight fit to present-day syringes.

Another big step forward in hypodermic syringe improvement has been the adaptation of alkali-free hard glass, such as resistance glass. This type of glass resists erosion caused by sterilization, medicaments and constant use. Properly annealed, these hard-glass syringes can be placed in boiling water without breaking.

While all these improvements widened the use and the popularity of Luer all-glass syringes, there still re-

mained the long-sought answer for a secure and easy method of removing and attaching the needle to the syringe. Since 1905 when Dr. Einhorn of Germany discovered novocaine and thereby greatly increased the use of local, block, spinal and sacral anesthesia, the demand had been growing for a satisfactory attachment of needle and syringe.

Col. F. S. Dickinson of Becton, Dickinson and Company, about 1925, designed and manufactured the Luer-Lok which provided the medical profession with this eagerly-sought, efficient, sturdy syringe and needle connection.

The Luer-Lok is a metal tip sealed to the glass syringe. It has an inside thread that engages the rim of the needle hub and needs only a half-turn either to fasten it securely to the syringe or to remove it. The Luer-Lok also practically eliminates a weakness of the ordinary glass syringe—tip breakage.

The latest revolutionary change in hypodermic syringe history, (developed also by Becton, Dickinson and Company), has been the recent introduction of its Multifit syringe. Heretofore, a syringe piston would fit only one syringe barrel—the barrel for which it had been specially hand-ground. A broken barrel or piston meant that its component would be useless.

Multifit syringes by B-D are manufactured without grinding of the barrel and are made to such precise standards that any Multifit glass piston will now fit any clear-glass Multifit syringe barrel.

This interchangeability means new economy. Unground barrels are tougher and longer-lasting—erosion resistant—because the glass "skin" hasn't been weakened by grinding. Multifits eliminate the necessity of using a certain piston with only a certain barrel. This latest development in the history of hypodermic syringes represents such a new and extreme departure in manufacturing that present standards of fitting, testing and performance of ground-glass syringes are so far exceeded they do not apply to Multifit syringes. ●

★ ★ ★ ★ ★

Not Chalk and Talk

(Continued from Page 128)

SOIL

1. Air in soil.
2. Water-holding capacity of soil.
3. Root systems penetrating soil.

FRUITS

1. Types of fruits.
2. Fruit dispersal.

HEALTH

1. Effect of sterilization, pasteurization, and storage temperature upon milk.
2. Petri dishes of nutrient agar exposed to everyday objects.
3. Removal of a colored bacterium from hands by washing hands different ways.

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Conservation Education

(Continued from Page 137)

the necessity for it. The talks as well as the endless books and countless reams written about the need have finally reached those in high places. Conservation has begun to be more than a mere word. Many already realize that it is synonymous with man's continued existence here on earth.

For nearly three decades we have insisted that it should be taught as a definite subject or at least as an adjunct to the regular courses of studies in both the elementary and secondary schools. Even as a mere starter it should be taught intensively in the first four or even five grades so that the child becomes as conversant with it as he is with the three R's. Is it too much to ask for something so important?

School boards and curriculum experts are at long last beginning to see the light. They have finally decided to do something about those things upon which our living depends. They see now that a child needs something more than the knowledge of how to make a living.

The human factor in conservation has been ignored altogether too long. You can't change the leopard's spots overnight. Neither is it possible to change with threats of destruction the elemental forces with which man has been endowed. It must be accomplished by an educative process; a process whose concepts must become second nature.

It is no longer a question of coming out of the wilderness and being cultured and educated so as to better cope with the ways of man. We are no longer fighting nature as we did in pioneer times. It is now high time to cooperate with her. Throughout their school years all children are made to feel that our natural resources are subjective rather than dynamic; as a means to an end, and that end being of primary importance to the person. We have developed a high standard of living at the expense of those things which should enable us to live amicably with other nations. We are today trying to make up those shortcomings by attempting to rehabilitate or arm or feed a vast array of impoverished nations at the expense of our own dwindling resources.

The teacher is a most powerful influence in determining the future thinking of his charges. Each and every child can be so thoroughly imbued or indoctrinated with the concepts of conservation as to make him a potent factor in the future determination of our fate. Succintly, the idea is to produce a generation of children so thoroughly impregnated with the necessity for conserving as to leave not the slightest doubt about their future direction when dealing with the problem. When the time comes they will take to it like the proverbial duck. There are those who would call it regimentation, yet it must be conceded that the method is an effective one. Why hesitate to use it for a worthy cause?

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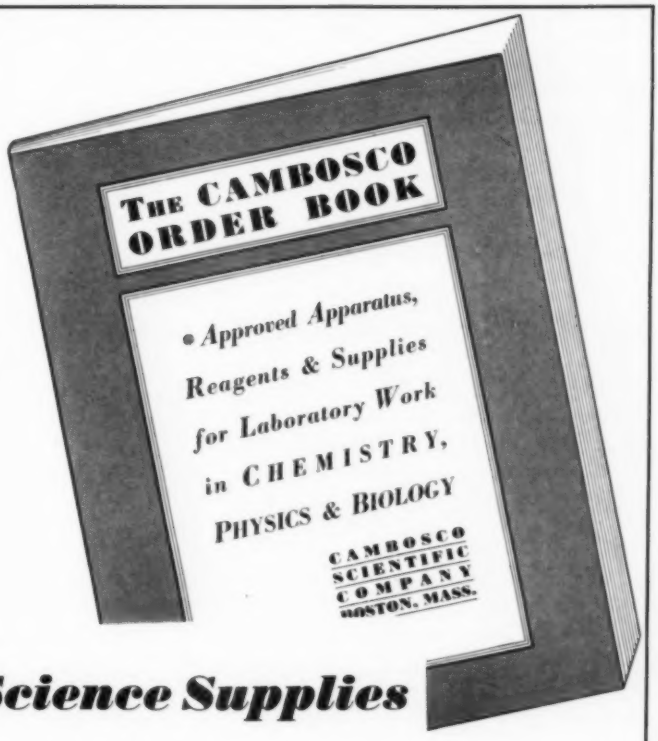
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Equipment? Primarily, a zest for living the American way; an appreciation of the things basically responsible for making life what it is plus a determination that those things shall not go for the sole aggrandizement of a few whether they are individuals or nations.

What good will it profit mankind to inherit the earth after it has been completely shorn of its riches? It would be as meaningless as conquest without victory. ●

★ ★ ★ ★ ★

Current Scientific Writing

(Continued from Page 140)

However, the professional science writer certainly has a place in promoting the interest of the laity in this field. Since he has had special training in the techniques of maintaining interest, he can often reach the public more easily than can the scientist. Despite the objection of scientists that science writers go out of their way to emphasize the unusual, we know that many people who will not read the less interesting articles by scientists are learning about their work through the articles of journalists.

Scientists are now beginning to write more for the layman, particularly books, but they are also contributing to periodicals. They are beginning to overcome the idea that writing for the layman is somewhat "debasing." One of the good qualities of the scientist's writing is clarity. He also uses concrete words where the journalist may use vague words. He is often more objective in his attitude than is the journalist.

However, the scientist can be criticized on a few points. Often he does not put enough human interest into his articles, and sometimes he becomes too technical and detailed for the average reader. In "Scientists Can Talk to the Layman" in *Science* magazine, John W. Hill expresses this criticism: "The scientist should remember that . . . he is no longer a chemist or a physicist; he is a translator as well." He is a translator in the sense that he must put his experiments, his research, and his conclusions into the language of the layman, and as such he must learn to use words which an average person can understand. He should also avoid confusing details. W. W. Pirie says:

> It would be better if scientists made their popular articles shorter, but the basic idea, that an article should be read rather than skimmed is sound . . . The important thing is that scientists should be encouraged to write for the general public. The effort educates the scientists, and the reader gets something different from his usual fare and something at least as good.

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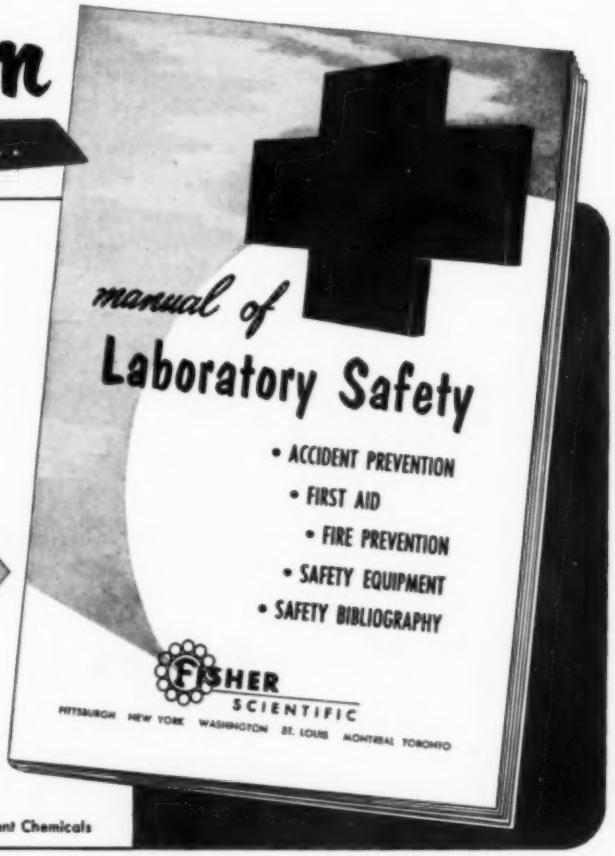
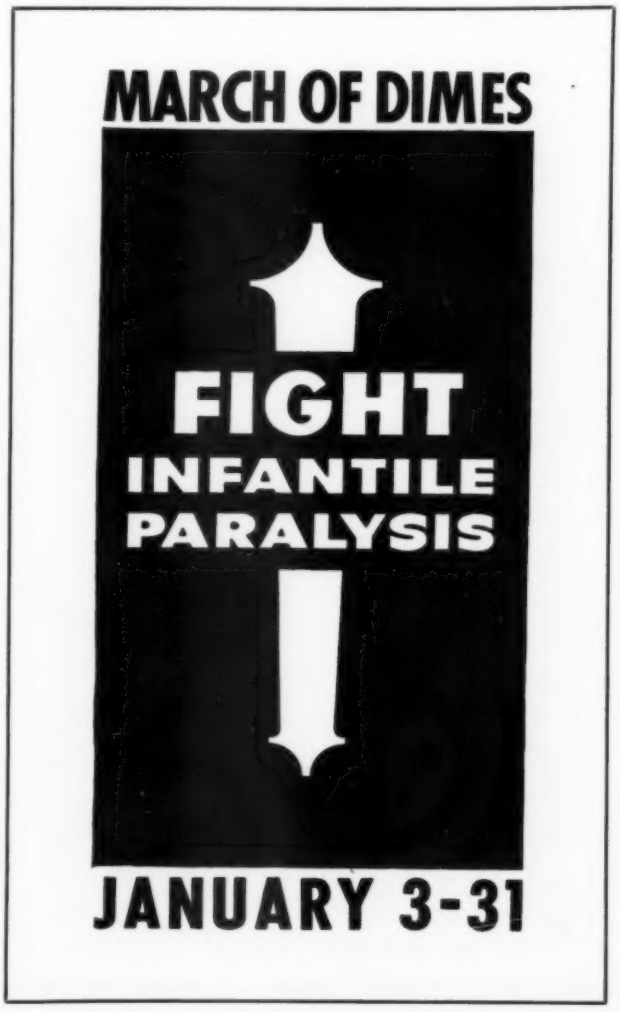


Some qualities critics would like to see introduced into scientific literature are the omission of emotive words, the use of verifiable statements, and illustration through pictures and tables. To increase the readability of scientific articles these critics suggest short sentences, concrete nouns, identification with reader, and emphasis.

Critical reading of the scientific articles used in this survey revealed generally consistent accuracy. However, I could nearly always distinguish between the articles written by the science writer and those written by the scientist; the articles of the former were less objective and sometimes appeared to be written more to entertain than to inform. Some means, of course, must be used to arouse interest, and perhaps the scientist should learn to write more interestingly and the journalist a little less sensationally. According to the trend shown in the survey, I think as people become more familiar with scientific principles, the writing in this field will become both more technical and more stimulating.

Following my evaluation of the two types of science articles I conclude that the science writer, in order to



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"interpret the human significance of new concepts of science" must be not only a scientist but a literary artist. He must as a scientist be systematic and exact, and as a literary artist be able to present his information in a clear, interesting manner.

Thus, I think that while there is much we can criticize about current science literature, we can also look forward to constant improvement. Because of the increasing import of scientific developments upon all phases of human activity, the public must read and analyze more current science literature.[1] It is becoming obvious that scientist-writers as well as professional science journalists are stressing a code of ethics based upon three principles: the sharing of new knowledge, the necessity for veracity, and the obligation to publish important findings. ●

★ ★ ★ ★ ★

High School Chemistry

(Continued from Page 135)

14. Dickerhoff, Charles, Chemistry Teacher, Dormont High School, Pittsburgh, Pennsylvania.
15. Ober, Galen, Chemistry Teacher, Hampton High School, Glenshaw, Pennsylvania.
16. Beck, C. F., Chemistry Teacher, Wilkinsburg High School, Pittsburgh, Pennsylvania.
17. Murray, James R., Chemistry Teacher, North Catholic High School, Pittsburgh, Pennsylvania.
18. D'Amato, Hugh A., Chemistry Teacher, Jeannette High School, Jeannette, Pennsylvania.
19. Father Louis, O.S.B., St. Vincent Preparatory School, Latrobe, Pennsylvania.
20. Sister M. Carmella, Chemistry Teacher, Our Lady of the Sacred Heart High School, Pittsburgh, Pennsylvania.
21. Gifford, Randall H., Chairman of Science Department, Hartford Public High School.
22. Sister M. Salome, Chemistry Teacher, Holy Trinity High School, Hartford, Conn.
23. Deady, Rt. Rev. Carroll F., Superintendent of Parochial Schools, Detroit, Michigan.

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(Continued from Page 132)

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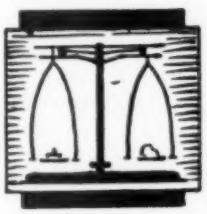

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Launderometric Evaluation

(Continued from Page 129)

by other ionic groups such as the sulfate (#14, 15 or 16) the succinate (#19, 20 and 21) or the maleate (#22). Neutral groups attached to cellulose such as allyl (#23) or hydroxyethyl (#25) have little effect on the launderometic activity although the latter appears to act as a depressant. Formation of carboxyl groups by N_2O_4 oxidation (#9 to 13) seems to aid activity at first. However, prolonged oxidation with probable degradation of the cellulosic portion of the molecule eventually results in decreasing activity of the product. Other oxidants (#1 to 8) appear to have little effect on activity.

It, therefore, appears that the carboxymethyl group is essential for its ionic dirt repelling property and the intact cellulose molecule is necessary for attachment to the cotton fabric as postulated by Nieuwenhuis[3].

A number of other polymeric substances were also tested by this procedure. Such substances as soluble starch, lactalbumin, hydroxypropylstarch, heparin, mucoitin sulfate, and agar showed slight activity while calcium caseinate showed moderate activity. On the other hand, a purified native lignin (Indulin A, West Virginia Paper and Pulp Co.) gave a reflectance reading (49%) equivalent to sodium carboxymethylcellulose itself*. From a practical standpoint, however, the use of lignin is not applicable because of its tendency to discolor soap powders.

* This can be explained by the affinity of native lignin for the cellulose molecule as well as the presence of ionic groups in the lignin.

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Albert C. Jacobs
President, Trinity College
Hartford, Conn.

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"Some lessons are written very boldly on the pages of history and none more boldly than this: 'They that forget God shall go down to destruction'."

Cardinal Spellman

INDEX TO VOLUME XVII

1954

Articles are listed under the author's name. Book reviews are listed under the name of the author of the book. (R) indicates a book review. The name of the reviewer follows in parentheses.

AELRED, SISTER M., Chemistry for the Non-College Student ... 7
ARCHAMBAULT, GEORGE F., Hospital Pharmacy as a Career ... 61
ARNOW, L. EARLE, "Introduction to Physiological and Pathological Chemistry," (R) (James C. Munch) ... 66
BELL SOLAR BATTERY ... 82
BRAUGHT, GENE, Solar Energy for the Production of High Temperatures ... 8
BUKER, W. E., Botany as a Hobby ... 95
BURROW, TRIGANT, "Science and Man's Behavior: The Contribution of Phylobiology," (R) (John L. McIntire) ... 65
CARLETON, CARPENTER and WOLINE, "Chemistry for the New Age," (R) (H. C. Muldoon) ... 141
CARLETON, WILLIAMS and BUELL, "Physics for the New Age," (R) (H. C. Muldoon) ... 141
CASILLO, N. R., Slants on Conservation Education ... 136
COOK, ELTON S., The Diversified Support of Basic Research in College ... 63
COULTER, JOHN WESLEY, Human Geography ... 13
CROWE ELECTRICRAFT CORP., "Rotating Electrical Machinery," (R) (H. C. Muldoon) ... 141
CUMMING, C. N. W., The Laboratory Animal ... 46
DIVISION OF SURVEYS, GEORGE PEABODY COLLEGE, "Free and Inexpensive Learning Materials," (R) (H. C. Muldoon) ... 108
DUGGAN, MARY LOU, Fluoridation for Health ... 104
DUVDEVANI, S., Cultivation of Food Plants in Dry Areas ... 2
EDWIN, SISTER M., Medical Technology for You? ... 15
GARRETT, ALFRED B., Science, A Cornerstone of Our Democracy ... 4
GATLAND and KUNESCH, "Space Travel," (R) (H. C. Muldoon) ... 106
GETCHELL, ROBERT W., "Organic Chemistry," (R) (M. Blake) ... 108
GRAM and WEBER, "Plant Diseases in Orchard, Nursery and Garden Crops," (R) (A. W. Poitras) ... 66
GRIFFIN, CARROLL W., "Inorganic Quantitative Analysis," (R) (M. Blake) ... 106
GURNEY, R. W., "Ionic Processes in Solution," (R) (Norman C. Li) ... 25
HADLOW, LEONARD, "Climate, Vegetation and Man," (R) (H. C. Muldoon) ... 108
HALL, COURTNEY R., "History of American Industrial Science," (R) (H. C. Muldoon) ... 65
HOHN, MATTHEW H., The Catherwood Diatometer ... 123
HOWE, EVERETT D., Fresh Water From the Sea ... 42
IN FUTURE NUMBERS ... 1, 41, 81, 117
INGERSOLL, MARTIN & ROUSE, "A Laboratory Manual of Experiments in Physics," (R) (A. J. Kozora) ... 25
KARABINOS, J. V., Launderometric Evaluation of Some Cellulose Derivatives ... 129
SOME EXPERIMENTS ON THE KOLBE SYNTHESIS ... 3
KELLY, W. C., Will Physics Disappear from Our High Schools? ... 88
KENNEDY, LOIS, Current Scientific Writing ... 139
KENT, GEORGE C. J., "Comparative Anatomy of the Vertebrates," (R) (J. G. Adams) ... 142
LACKEY, JAMES B., Water-Managed or Mismanaged? ... 85
LASTHUYSEN, WILLEM, Taste and Flavor ... 50
LAWRENCE, SISTER M., Modern Trends in High School Chemistry ... 133
LEWIS, LUCIA Z., Microbes at Work ... 45
LEYSON and MANECKE, "The Zoo Comes to You," (R) (H. C. Muldoon) ... 106
LILLIE, R. D., "Histopathologic Technic and Practical Histochemistry," (R) (A. C. Neva) ... 142
MARCOVITCH, S., The Importance of Magnesium in Human Nutrition ... 125
MARGENAU, WATSON & MONTGOMERY, "Physics, Principles and Application," (R) (A. J. KOZORA) ... 25
MCCARTHY, RAYMOND G., Changing Emphasis in Instruction About Alcohol ... 121
MCDOWELL, SR. MARGARET ANN, The Cancer Problem—A Challenge to Scientific Research ... 55
MCLAUGHLIN, P. J., "Modern Science and God," (R) (H. J. Koren) ... 142
MCWHINNIE, MARY A., The Physiological Approach to Zoology ... 100
MICHAEL, SISTER M., The Need for an Alternative Course for Solid Geometry ... 17
MILLER, P. SCHUYLER, An American Alchemist ... 97
MOORE, CLIFFORD B., "Ways of Mammals in Fact and Fancy," (R) (J. C. Munch) ... 66
MOYER, JOHN W., "Practical Taxidermy," (R) (J. C. Munch) ... 66
NELSEN, O. E., "Comparative Embryology of the Vertebrates," (R) (R. Heckerman) ... 24
NEW BOOKS ... 24, 65, 106, 141
NEWTON, NELSON H., Ultrasonics—A Physical Tool for Biological Research ... 130
OLIVA, A. T., Personality Factors in Human Relations ... 18
PINNER, ERNA, "Curious Creatures," (R) (J. C. Munch) ... 65
PODOLSKY, EDWARD, "Musical Therapy," (R) (H. C. Muldoon) ... 66
RICHARDS, O. W., "The Social Insects," (R) (H. C. Muldoon) ... 25
RICHARDSON, JOHN S., "School Science Facilities," (R) (H. C. Muldoon) ... 142
ROSSINI, FREDERICK D., Research in Petroleum Chemistry ... 91
SCHONEFIELD, H. J., "The Suez Canal in World Affairs," (R) (H. C, Muldoon) ... 24
SHOEMAKER, COMLY B., Out of Doors ... 22
SIGHT OF SOUND, THE ... 118
SMITH and VANCE, "Science for Everyday Use," (R) (H. C. Muldoon) ... 141
STAVELY, HOMER E., The Search for Plasma Volume Expanders ... 10
STOLLER, LEONARD, There's More to a Perfume Than Meets the Nose ... 102
STORY OF HYPODERMIC SYRINGES, THE ... 138
STREMLAU, REV. GORDIAN, The Teaching of Graphs ... 49
THORNE and PETERSON, "Irrigated Soils," (R) (H. C. Muldoon) ... 141
TIGGES, HERBERT L., Machine Tools ... 59
UNDERKOFLER and HICKEY, "Industrial Fermentations," (R) (H. C. Muldoon) ... 142
VANCE and MILLER, "Biology for You," (R) (H. C. Muldoon) ... 141
VAN PEURSEM and IMES, "Elementary Quantitative Analysis," (R) (M. Blake) ... 24
VROOM, PETER, An Elementary Science Project—A Frieze ... 20
WALSH, LYDIA BOURNE, Not Chalk and Talk ... 127
WATKINS, HAROLD, "Time Counts—The Story of the Calendar," (R) (H. C. Muldoon) ... 106
WEAVER and FOSTER, "Chemistry for Our Times," (R) (H. C. Muldoon) ... 25
WILLIAM, BRO. GERVASIAN, Modern Trends in Teaching Mathematics in High School ... 54
WISTAR, RICHARD, "Man and His Physical Universe," (R) (H. C. Muldoon) ... 25
WOODBURN, JOHN H., The Program and Purpose of the Future Scientists of America Foundation ... 90
WOOLLEY, SIR LEONARD, "Spadework," (R) (H. C. Muldoon) ... 106

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